A revision of Grimmia (Grimmiaceae) from South Africa and Lesotho

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A revision of Grimmia (Grimmiaceae) from South Africa and Lesotho

Eva Maier†, Michelle J. Price & Terry A. Hedderson

Abstract

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A revision of *Grimmia* Hedw. *(Grimmiaceae)* from South Africa and Lesotho based on specimens housed in BM, BOL, G, PRE, and STU, as well as type material from B, BM, BOL, FH, G, H-BR, H-SOL, NY, and PRE, is presented. Thirteen species are recognized for South Africa and Lesotho: *Grimmia consobrina* Müll. Hal., *Grimmia donniana* Sm., *Grimmia elongata* Kaulf., *Grimmia fuscolutea* Hook., *Grimmia kidderi* James, *Grimmia laevigata* (Brid.) Brid., *Grimmia longirostris* Hook., *Grimmia montana* Bruch & Schimp., *Grimmia orbicularis* Wilson, *Grimmia pulvinata* (Hedw.) Sm., *Grimmia pygmaea* Müll. Hal., *Grimmia sessitana* De Not. and *Grimmia tortuosa* Hook. f. & Wilson. Keys based on morphological features, with an emphasis on costal characters, are provided. Each species is described and illustrated using key morphological and anatomical characters, such as transverse sections of leaves. Methods of specimen preparation are also explained and a glossary is supplied. Information on the geographical as well as altitudinal distribution of each species is given, with species distribution maps provided for the area covered by this study.

Keywords

GRIMMIACEAE – *Grimmia* – Lesotho – South Africa – Costal anatomy – Glossary

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Introduction

Grimmia (Grimmiaceae) is a large genus of mosses, comprising 51 predominantly saxicolous species (Maier, 2010), which is found on all continents. Although the genus is cosmopolitan in distribution, concentrations of species diversity are found in the Holarctic, with considerably lower species diversity in the southern hemisphere (Muñoz & Pando, 2000). The most recent African checklist (O'Shea, 2006) recognised 22 species for the continent, whilst Van Rooy & Perold (2006) recognised nine species for South Africa (*G. argyrotricha* Müll. Hal., *G. donniana* Sm., *G. elongata* Kaulf., *G. fuscolutea* Hook., *G. laevigata* (Brid.) Brid., *G. longirostris* Hook., *G. pulvinata* (Hedw.) Sm., *G. reflexidens* Müll. Hal. and *G. trichophylla* Grev.).

Field studies in South Africa over the past decade, especially in the Western and Northern Cape Provinces, have yielded a large number of *Grimmia* specimens, many of which had proven difficult to assign to any of the species currently recorded from the country. In addition, the examination of available herbarium holdings for South Africa and Lesotho revealed that many previous collections were misidentified. Both these findings highlight the clear need for a revision of *Grimmia* in southern Africa.

Based on the examination of more than 600 herbarium specimens housed in BM, BOL, G, PRE and STU (formerly in Herb. Lübenau) and types from B, BM, BOL, FH, G, H-BR, H-SOL, NY and PRE seen in the context of an earlier publication (Maier, 2010), we recognise thirteen *Grimmia* species from South Africa and Lesotho: *G. consobrina* Müll. Hal., *G. donniana*, *G. elongata*, *G. fuscolutea*, *G. kidderi* James, *G. laevigata*, *G. longirostris*, *G. montana* Bruch & Schimp., *G. orbicularis* Wilson, *G. pulvinata*, *G. pygmaea* Müll. Hal., *G. sessitana* De Not. and *G. tortuosa* Hook. f. & Wilson. Herein we provide identification keys to these species, with detailed descriptions and illustrations, based on material from South Africa and Lesotho and the cited types. We also document the regional and altitudinal distribution of each species based on the material studied.

Diversity and distribution within the study area

Of the thirteen species recognised in South Africa and Lesotho, only two (*G. laevigata* and *G. pulvinata*) may be considered common and widespread: all others demonstrate varying degrees of range restriction, typically to the higher mountains of the Western Cape and/or the Drakensberg.

Species richness mapped at the quarter-degree square (QDS) level (Fig. 1A), reveals three main areas of high diversity. The first is in the Drakensberg, where nine of the thirteen species occur, two of which (*G. donniana* and *G. longirostris*) are restricted to this region. Two additional centres of high diversity are the Hex River Mountains (nine species) and the northern and middle Cederberg (eight species). These two areas have very similar *Grimmia* floras; *G. kidderi* occurs in the Cederberg but is not currently known from the Hex River mountains, whilst the reverse is true for *G. tortuosa*. Furthermore, several species (*G. consobrina*, *G. montana*, and *G. kidderi*) are relatively common in one or both of these two centres, but occur as isolated populations in the Drakensberg and/or on the Great Escarpment of the Eastern Cape.

The map of species richness (Fig. 1A) also reveals that over very large portions of the country no *Grimmia* species have been recorded. In some areas, for example the lowlands of KwaZulu-Natal, and along the northeast border with Mozambique, this may reflect a true absence of the genus. Over the rest of the country, however, the absence of *Grimmia* records is much more likely to reflect a lack of collecting activity. Across the Karoo, for example, at least *G. laevigata* and *G. pulvinata* are likely to be present in every QDS. Similarly, future collection efforts focused on the Great Escarpment are likely to reveal many additional localities for species such as *G. consobrina*, *G. fuscolutea* and *G. kidderi*. Distribution maps for the 13 species recognized are included herein (Fig. 1B-F, 2A-F).

Materials and methods

The material used for the descriptions in this study consisted of 624 specimens from South Africa and Lesotho seen at or loaned from BM, BOL, G, PRE, STU and the private herbaria of R. Lübenau (now in STU) and H. Matcham as well as types from B, BM, BOL, FH, G, H-BR, H-SOL, NY and PRE.

The collections that were available for the present work revealed the rarity of plants with sporophytes within the study area. The few capsules present in the few fertile specimens were often immature, and if mature were rarely well developed or were extremely brittle or even decomposed, and thus were inappropriate for obtaining satisfying descriptions and drawings of the sporophytes. The descriptions of the sporophytes for species treated herein are therefore largely taken from Maier (2010).

The fragile state of the plants, especially the sporophytes, may be due to abiotic interactions such as drought stress, heat stress or both combined, encountered under extreme environmental growing conditions (Cullis, 2004: 131). Perhaps more importantly, collection times are strongly biased towards the hot summer, whilst many of the species grow and produce sporophytes in the cooler and wetter winter months, especially in the winter rainfall areas of the Western Cape.

The first impression of a *Grimmia* species is given by the habit of its cushions. Young shoots, in many cases useful for identification, are best viewed on the reverse side and in the internal part of the cushion. Wetting induces the typical movement of the leaves, which is observable under the dissecting microscope by pushing a plant into a drop of water. Development of sexual organs may

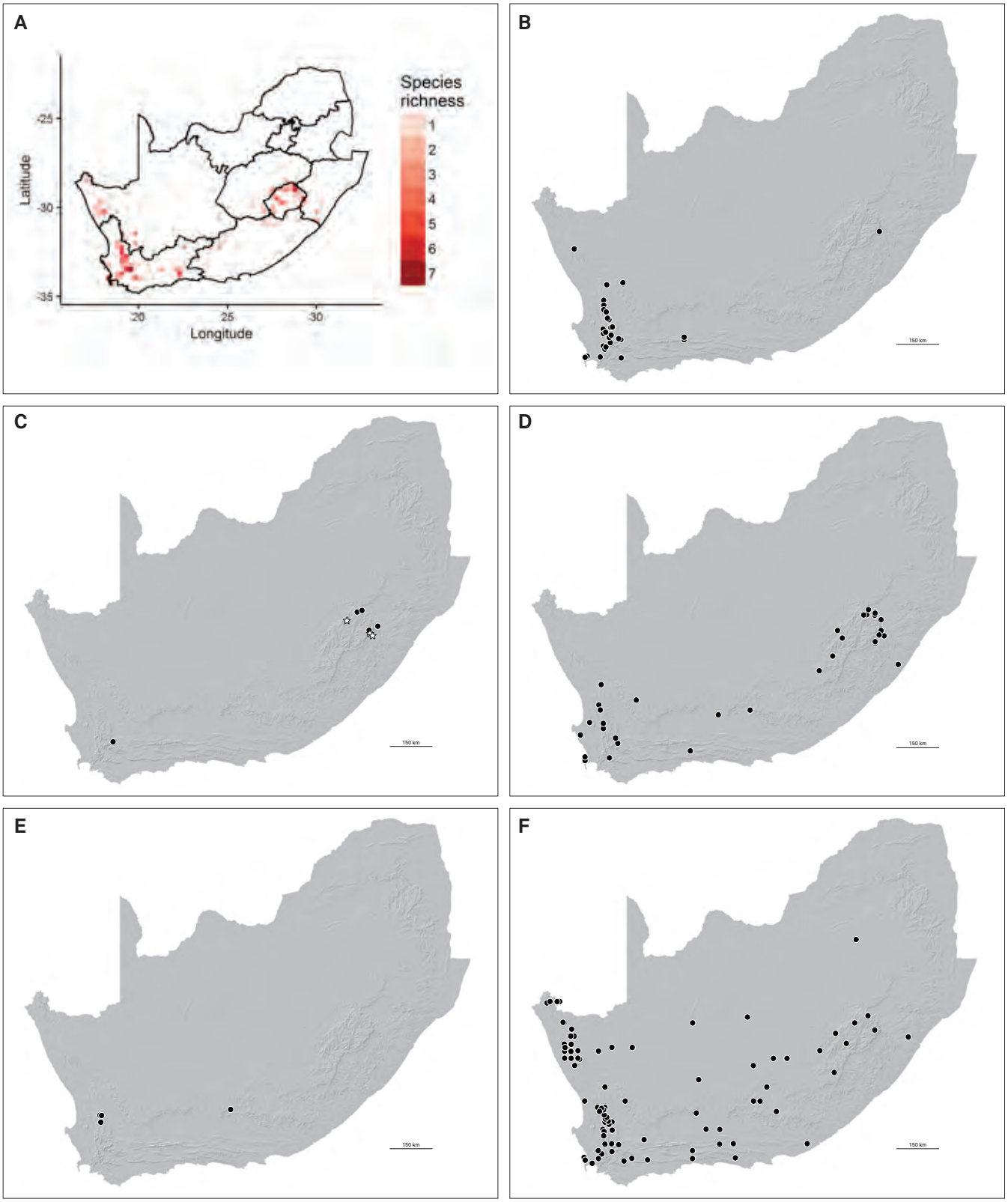

Fig. 1 – Species richness (**A**) and geographic distribution (**B-F**) of *Grimmia* Hedw. species in South Africa and Lesotho. **A.** Distribution of species richness in the genus *Grimmia* Hedw. at the Quarter-Degree Square (QDS) scale; **B.** *Grimmia consobrina* Müll. Hal.; **C.** *Grimmia donniana* Sm. (stars) and *G. elongata* Kaulf. (circles); **D.** *Grimmia fuscolutea* Hook.; **E.** *Grimmia kidderi* James; **F.** *Grimmia laevigata* (Brid.) Brid.

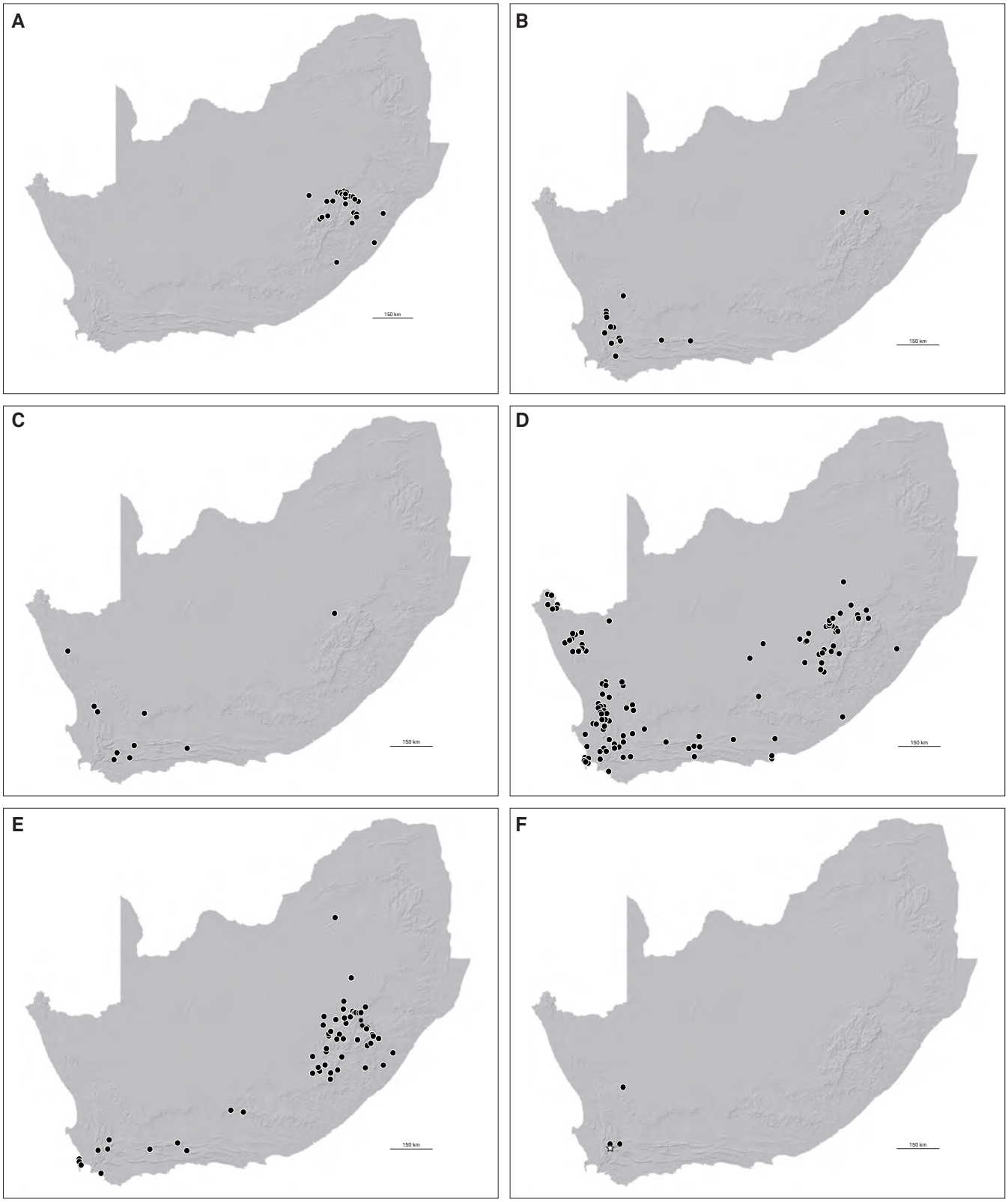

Fig. 2 – Geographic distribution of *Grimmia* Hedw. species in South Africa and Lesotho. **A.** *Grimmia longirostris* Hook.; **B.** *Grimmia montana* Bruch & Schimp.; **C.** *Grimmia orbicularis* Wilson; **D.** *Grimmia pulvinata* (Hedw.) Sm.; **E.** *Grimmia pygmaea* Müll. Hal.; **F.** *Grimmia sessitana* De Not. (circles) and *G. tortuosa* Hook. f. & Wilson (star).

influence the expression of cell patterns in the leaf bases, therefore plants in the vegetative state should be chosen to obtain comparable and reproducible results during morphological and anatomical investigations. The plants are prepared by gently heating them in a basic solution of 1-2 % KOH. This is a simple but indispensable method used to soften dry and/or old herbarium material, to reconstitute the natural structure of the cells and to induce tissue transparency and stability, thus preventing the shrinking of cells that may be provoked by embedding agents.

Leaves that are not too young, from the upper stem area but not the apex, are carefully removed one by one to prevent damage to the delicate tissues at the leaf base (this area is important as it often contains specific characters). A fine soft watercolour brush is then used to remove any dirt or debris from the selected leaves. Transverse sections of the stem and the leaves are cut freehand with a razor blade directly on the microscope slide. Comparable transverse sections are obtained only when the razor blade is placed in a perpendicular position and at a right angle to the leaf axis. To obtain an instructive series of transverse sections, two leaves should be used. One is cut from the apex down to mid-leaf, the other from the insertion up to mid-leaf. This is a good method to ensure that sections have been made from the entire length of the leaf (see in Maier, 2010 for further explanations of preparation techniques).

Diagnostic characters are selected specific characters that distinguish a species. The examination of a large number of specimens brings to light the variability of characters initially thought to be specific and present only in the species investigated. Such characters were progressively eliminated from the diagnostic list by an ongoing selection process. The few remaining characters then can be considered to be species specific and, when considered collectively, stable enough to differentiate one species from another.

Figures for the thirteen species now recognised for South Africa and Lesotho, namely *G. consobrina* (Fig. 3), *G. donniana* (Fig. 4), *G. elongata* (Fig. 5), *G. fuscolutea* (Fig. 6), *G. kidderi* (Fig. 7), *G. laevigata* (Fig. 8), *G. longirostris* (Fig. 9), *G. montana* (Fig. 10), *G. orbicularis* (Fig. 11), *G. pulvinata* (Fig. 12), *G. pygmaea* (Fig. 13), *G. sessitana* (Fig. 14) and *G. tortuosa* (Fig. 15), were drawn from material originating in the study area.

An overview of the species descriptions

Descriptions of individual plants provided here, following the model given in Maier (2010), are based on moistened material, whilst those of growth forms are based on dry specimens. Leaf measurements exclude the hair-points, and seta measurements do not include vaginulae. The descriptions of perichaetial and perigonial leaves refer to the innermost ones. The description of the gametophyte is based on sterile plants. When determining material attention should be paid to the differences in the cell pattern of the leaf base depending on developmental stage and sexual condition of the plants. In general, strongly elongate basal cells may occur in leaves located below the developing perichaetia or perigonia. Descriptions of the calyptra and vaginula are included under the sporophytes. A full explanation of the methodology behind the descriptions can be found in Maier (2010: 36).

Identification keys

Successful use of the keys requires preparation of specimens as described under the Materials and Methods section. The first key is for the Grimmiaceae from the study area, namely *Coscinodon* Spreng., *Grimmia*, *Racomitrium* Brid., *Schistidium* Bruch & Schimp. and the second is for the thirteen species recognized for South Africa and Lesotho herein.

Key to Grimmia and related genera from South Africa and Lesotho

1. Cells in leaf base elongate with conjointly thickened and sinuose walls; dry seta twisted from right side below to left side above, seen in surface view ..... ***Racomitrium***

1a. Cells in leaf base not elongate with conjointly thickened and sinuose walls; dry seta otherwise **2**

2. Costal cells in transverse section scarcely differentiated; seta not twisted when dry, at dehiscence columella remains attached to operculum ..... ***Schistidium***

2a. Costal cells in transverse section differentiated; seta twisted from left side below to right side above when dry, at dehiscence columella not attached to operculum **3**

3. Spore sac attached to the capsule wall, air space scarcely developed ..... ***Grimmia***

3a. Spore sac attached to the capsule rim, air space well-developed ..... ***Coscinodon***

Key to Grimmia species from South Africa and Lesotho

As plants are often collected without sporophytes, and when present the sporophytes are often in poor condition, we have utilised only gametophytic characters. (Plants should be examined in the wet state).

1. Cross section of costa at insertion with 7 or more guide cells (see Fig. 8G, H), in lamina with 2 guide cells sunken into narrow channel, their adaxial walls strongly thickened, at insertion with a small median band of substereids, interrupted by 3 groups or 1 large central group of hydroids that vanish in the apical part ..... 6. ***G. laevigata***

1a. Costa cross section at insertion with fewer than 7 guide cells **2**

2. Costa cross section at insertion with 6 guide cells (see Fig. 9F); in lower lamina costa unevenly rounded and somewhat angulate as seen in surface view, indistinct in apical part of leaf; basal cells with transverse walls

markedly thinner than longitudinal ..... 7. ***G. longirostris***

2a. Costa at insertion with 4 guide cells or with 4 guide cells of which the outer two are contiguous with the basal cells **3**

3. Costa at insertion with 4 guide cells, outer guide cells non-contiguous with the laminal cells **4**

3a. Costa at insertion with 4 guide cells, the two outer ones contiguous with the laminal cells (see Fig. 3F, G; 6G, H) **12**

4. Basal paracostal cells (excluding marginal cells) nodulose..... **5**

4a. Basal paracostal cells (including marginal cells) smooth **8**

5. Transverse section of leaf base not concave, leaf base with a marginal border (see Fig. 5F) of narrowly elongate-rectangular, hyaline, thin walled cells in 3-4 rows, gradually transitioning to short-rectangular to quadrate cells but with outermost row ascending to above broadest part of leaf; margin recurved on one side from insertion to mid-leaf (see Fig. 5C, D); lamina unistratose (see Fig. 5H), rarely with bistratose patches..... 3. ***G. elongata***

5a. Transverse section of leaf base concave, plants otherwise ... **6**

6. Transverse section of leaf above broadest part broadly keeled (see Fig. 7I), unistratose at insertion and leaf base, partially bistratose in laminal part, bistratose in apex; margin with several rows of bistratose cells; costa in transverse section (see Fig. 7I), with or without hydroids, cells in transitional part of leaf with walls smooth or sinuose (see Fig. 7H) ..... 5. ***G. kidderi***

6a. Transverse section of leaf above broadest part not broadly keeled; plants lacking the above combination of characters **7**

7. Transverse section of costa at insertion with dorsal cell walls slightly bulging (see Fig. 13J, K), below mid-leaf with 2 narrowly elliptical median guide cells arranged obliquely to leaf axis; marginal cells partly bi-tristratose in 1-3 rows above the leaf base; laminal cells in transitional zone elongate-rectangular (see Fig. 13G, I), walls sinuose ..... 11. ***G. pygmaea***

7a. Transverse section of costa at insertion with dorsal cell walls bulging (see Fig. 11H), the guide cells rounded, arranged horizontally; margin unistratose or at most bistratose in 1 cell row on one side in apex; lamina cells in transitional zone short-rectangular or isodiametric with walls smooth or slightly sinuose (see Fig. 11G) .... 9. ***G. orbicularis***

8. Cells in leaf base elongate-rectangular..... **9**

8a. Cells in leaf base short-rectangular..... **11**

9. Basal cells of upper stem leaves elongate-rectangular (see Fig. 14D), with thickened transverse walls throughout; lower stem leaves with inner elongate rectangular and evenly thickened walls (see Fig. 14E), but with 2-3 marginal rows short-rectangular to quadrate cells and with thickened transverse walls; margin (transverse section) (see Fig. 14C) plane or occasionally recurved on one side from insertion to transitional zone (see Fig. 14F) ..... 12. ***G. sessitana***

9a. Cells of leaf base elongate-rectangular, hyaline with cell walls evenly thin, margins plane..... **10**

10. Costa in transverse section markedly stout in the lamina (see Fig. 15H), indistinct at apex, without hydroids but with abundant stereids; leaf forming a v-shape in cross-section in upper leaf..... 13. ***G. tortuosa***

10a. Costa in transverse section not markedly stout in laminal part, distinct at apex; transverse section with hydroids, stereids absent but substereids usually present; leaf section otherwise in upper leaf..... 2. ***G. donniana***

11. Leaves abruptly lanceolate from ovate base (see Fig. 10B), thus with distinct shoulders, keeled (transverse section) from mid-leaf to apex (see Fig. 10H, I); in transverse section margin gradually incurved from base to apex (see Fig. 10D, I), lamina bistratose (see Fig. 10H, I), costa prominent above leaf base..... 8. ***G. montana***

11a. Leaves broad-lanceolate or lanceolate from a short, ovate leaf base, keeled from leaf base to apex (transverse section) (see Fig. 12H, I), thus lacking distinct shoulders, in transverse section margin recurved on one side to above mid-leaf (see Fig. 12C), rarely on both sides and then with one side recurved only at middle of leaf; lamina unistratose from insertion to apex (see Fig. 12H), usually with marginal 1-2 cell rows that are bi- tristratose, occasionally only on one side and rarely unistratose (Fig. 12I), costa prominent throughout..... 10. ***G. pulvinata***

12. Costa in dorsal view strikingly small and thin from insertion to broadest part of leaf (Fig. 3B), becoming stout and prominent towards the apex; transverse sections of costa in the upper stout portion with a group of hydroids (see Fig. 3F, G); leaf bases auriculate, decurrent (see Fig. 3D) ..... 1. ***G. consobrina***

12a. Costa in dorsal view weak at insertion and leaf base but enlarged throughout laminal part (Fig. 6B); above the broadest part of leaf the 2 median guide cells become narrowly elliptical and obliquely oriented to leaf axis (see Fig. 6G, H); hydroids sometimes present in leaf base (see Fig. 6H); leaf bases neither auriculate nor decurrent ..... 4. ***G. fuscolutea***

Taxonomic treatment

Grimmia Hedw., Sp. Musc. Frond.: 75. 1801.

Note. – A description of the genus *Grimmia* can be found in Maier (2010: 14).

1. ***Grimmia consobrina*** Müll. Hal., Syn. Musc. Frond. 1: 785. 1849 (Fig. 3).

Lectotypus (designated by Muñoz, 1999: 176): **Chile:** *sine loc.,* s.d., *Pöppig s.n.* (NY [NY00322587]!; isolecto-: BM [BM000670949, BM000670950]!).

Gametophyte. *Dioicous. Female:* innermost perichaetial leaf tubulose, to 3 mm long; *male:* plants in separate cushions with stem leaves mostly muticous, perigonia in multi-foliose buds, terminal and in leaf axils, several on a stem, innermost perigonial leaf concave. *Growth form*: dense cushions, adhering to substrate, plants radiculose at base, ascending, weakly branched, stems 0.5 to 1.5 mm high, capsule-bearing plants reaching up to 2.5 mm in height, central strand weak. *Leaves* becoming longer from stem base to tip, 1.5-3.0 mm long, of irregular length in capsule-bearing plants, imbricate, loosely arranged and slightly turned around stem, apices spreading when dry, older leaves quickly bending backwards when moistened, younger ones slowly so, patent to patulous when wet, in comal tuft patulous, from elongate-ovate, at insertion slightly narrowed, decurrent, auriculate leaf base tapering to acuminate apex, symmetric or falcate, muticous or with very short to elongate, bluntly denticulate hair-point, development of brood-bodies occurs on dorsal side of lamina in transitional part, destroying lamina cells only; *leaf form in situ*, at insertion and leaf base concave, lower laminal part keeled, upper part narrowly so, margin on one side recurved from insertion up to mid-leaf; basal paracostal cells elongate-rectangular, walls smooth or nodulose, towards margin several rows of short-rectangular or nearly quadrate, hyaline cells with smooth or nodulose walls reaching up to transitional part, at margin 2 rows of short- to elongate-rectangular hyaline cells with smooth walls, vanishing in transitional part or shortly above it, cells in transitional part and lower half of lamina rectangular with nodulose walls, in upper half nearly isodiametric, lumina irregular, oval or rounded; in transverse section leaf unistratose throughout, rarely bistratose in laminal part, at margin from above insertion up to below apical part one row of cells bistratose, in apex 2 or more rows bistratose. *Costa*, seen from dorsal side, strikingly small and thin from insertion up to broadest part of leaf compared to its stoutness in the laminal part, excurrent to hair-point, in transverse section costa weak on dorsal side at insertion, from leaf base up to apex rounded, channelled on ventral side to upper laminal part, narrowly so in apical part, at insertion 4 guide cells, the 2 outer belonging partly to paracostal cells, from leaf base up to apex 2 guide cells, a band of stereids, in upper laminal part a group of hydroids or substereids, in smaller plants stereids throughout.

Sporophyte. *Seta* arcuate wet, straight when dry, to 3.5 mm long. *Capsule* obloid, ribbed, pendent or horizontal, apophysis well-developed, stomata numerous in 2 rows in the apophysis, annulus of 3-4 rows of cells, detaching as spirals. *Calyptra* conical, mitrate, lobed, covering operculum. *Operculum* conical, rostrate, beak straight or slightly oblique. *Peristome* teeth erect when dry, lanceolate, in upper part slit in two small branches, lower half more or less perforate, densely covered with fine papillae, apices rarely with rounded papillae, the outer lowest plates nearly smooth or with few fine papillae, trabeculae broad throughout, distant, strongly protruding, prostome more or less developed. *Spores* 11-16 µm, finely granulose.

Diagnostic characters. – Gametophyte. Leaves becoming longer towards the apex of the stem (Fig. 3B); costa at insertion and in leaf base strikingly thin and small compared to its stout appearance in the laminal part (Fig. 3F, G); hydroids or substereids present in upper part of costa. Sporophyte. Capsule with well-developed apophysis; peristome teeth with trabeculae broad, distant, protruding.

Distribution, habitat and ecology. – *Grimmia consobrina* is essentially a south-temperate species known from southern Africa, Australia, New Zealand, and southern South America, but extending northwards along the Andes into Central America and the mountains of Mexico and California.

In South Africa and Lesotho (Fig. 1B) this species is common in the mountains of the Western Cape, where it occurs predominantly on nutrient-poor quartzitic sandstones in fynbos at altitudes from 450-2,000 m. It is especially common in the Cedarberg-Koue Bokkeveld-Groot Winterhoek area, extending eastward through the Cape Fold Mountains to the Swartberg, where it becomes more rare. Also known from two disjunct localities in the Drakensberg of Lesotho and adjacent South Africa, where it occurs on basalt rocks in alpine grasslands.

Notes. – A total of 64 specimens were examined, of which 16 had sporophytes, two of which had capsules in a suitable state. The nature of the costa in *G. consobrina*, which is strikingly thin at the insertion compared to its prominence in the laminal part, is unique among *Grimmia* species. The auriculate leaf base is best seen in well-developed leaves that are carefully removed, one by one, as the alar cells are very fragile. The more or less rectangular cell rows at the margins of the leaf base appear as a hyaline zone that narrows towards the broadest part of the leaf. Plants with leaves that are predominantly muticous have been named *G. imberbis* Müll. Hal. (a synonym of *G. consobrina*, see Maier, 2010).

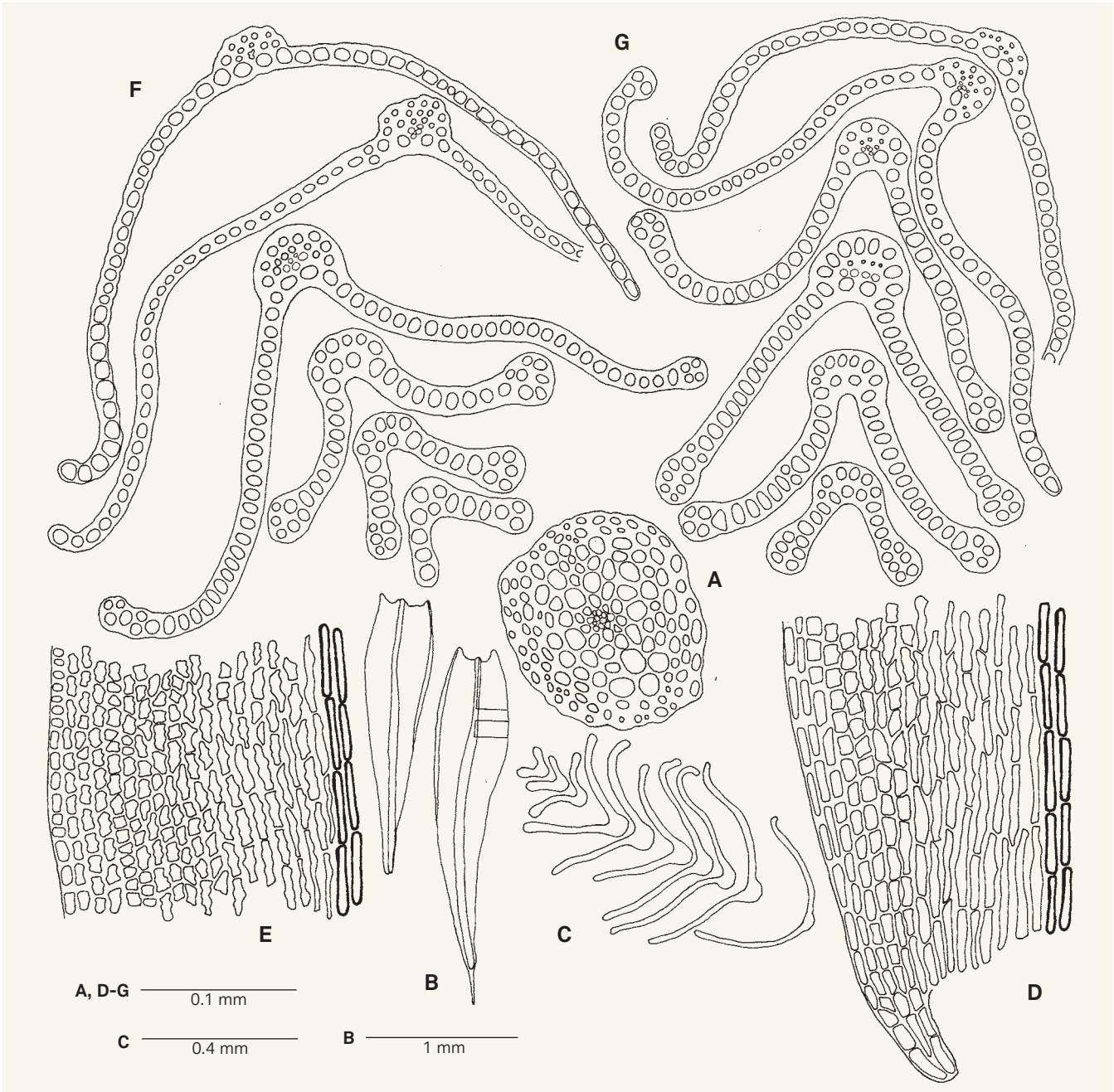

Fig. 3. – *Grimmia consobrina* Müll. Hal. **A.** Transverse section of stem; **B.** Leaves; **C.** Outlines of transverse section of leaf; **D.** Cells in leaf base; **E.** Cells in transitional part of leaf; **F-G.** Transverse sections of leaves.
[A-B, G: *Hedderson 13754*, BOL; **C:** *Hedderson 13726*, BOL; **D**-**E:** *Hedderson 13088*, BOL; **F:** *Hedderson 13678*, BOL].

In the study area, *G. consobrina* has frequently been misidentified as *G. trichophylla*, a species that is absent from South Africa and Lesotho.

Selected specimens examined. – **South Africa. Prov. Western Cape:** Cederberg, Zuurvlakte, c. 1150 m, 32°36'32"S 19°12'12"E", 27.II.2000, *Hedderson 13088* (BOL); Citrusdal Region, Cederberg State Forest Welbedacht Kloof, 900-1300 m, 32°24'30"S 19°10'24"E, 17.II.2001, *Hedderson 13678* (BOL); *ibid. loc.,* E side of Langberg and slopes of Shadow Peak, 1550-1870 m, 32°23'20"S 19°10'25"E, 17.II.2001, *Hedderson 13726* (BOL); Koue Bokkeveld Mountains, Twee Riviere, Suikerbossie Farm, c. 900 m, 32°40'30"S 19°16'02"E, 7.IV.2001, *Hedderson 13754* (BOL).

2. ***Grimmia donniana*** Sm. in Engl. Bot. 18: 1259. 1804 (Fig. 4).

Lectotypus (designated by Muñoz, 1998: 378) **United Kingdom [Wales]:** Pales at Beddgelart [Beddgelert], VII.1802, *Turner s.n.* (BM [BM000918087!]).

Gametophyte. *Monoicous. Female:* innermost perichaetial leaf to 2.5 mm long, sheathing to mid-leaf, not very different from stem leaves in shape and cell pattern, lower part of leaf hyaline, costa percurrent, hair-point long, denticulate; *male:* perigonia on short subperichaetial branches as buds on short stalks in leaf axils, innermost perigonial leaf 0.8 mm long, sheathing to broadest part, ovate, obtuse or mucronate, muticous or with acute hyaline end cell, in lower part or from base to below leaf tip hyaline, costa weak, percurrent, antheridia with few paraphyses. *Growth form*: dense, compact cushions, adherent to substrate by rhizoids, young shoots originating from rhizoids or older stem parts, leaflets muticous, apex acute, stems to 20 mm long, plants erect, branched, radiculose at base, central strand developed. *Leaves* in lower part of stem small, muticous, in upper part to 2.4 mm long, loosely arranged on stem, apices slightly bent towards stem when dry, longer leaves bending backwards, shorter leaves moving slightly when moistened, erecto-patent when wet, from narrow base elongate-lanceolate, tapering to rounded or obtuse apex, hair-point elongate, smoothly denticulate; *leaf form in situ*, at insertion and in leaf base concave, lower laminal part keeled, upper part narrowly so, margins plane throughout; basal paracostal cells elongate-rectangular, walls smooth, towards margin some rows of elongate-rectangular, hyaline cells present, longitudinal and transverse walls evenly thin, smooth, the rows gradually vanishing, outermost row reaching to above broadest part of leaf, thus forming a delimitation between hyaline and thicker walled chlorophyllose cells running obliquely from costa to margin, cells in transitional part near costa rectangular, walls sinuose, towards margin

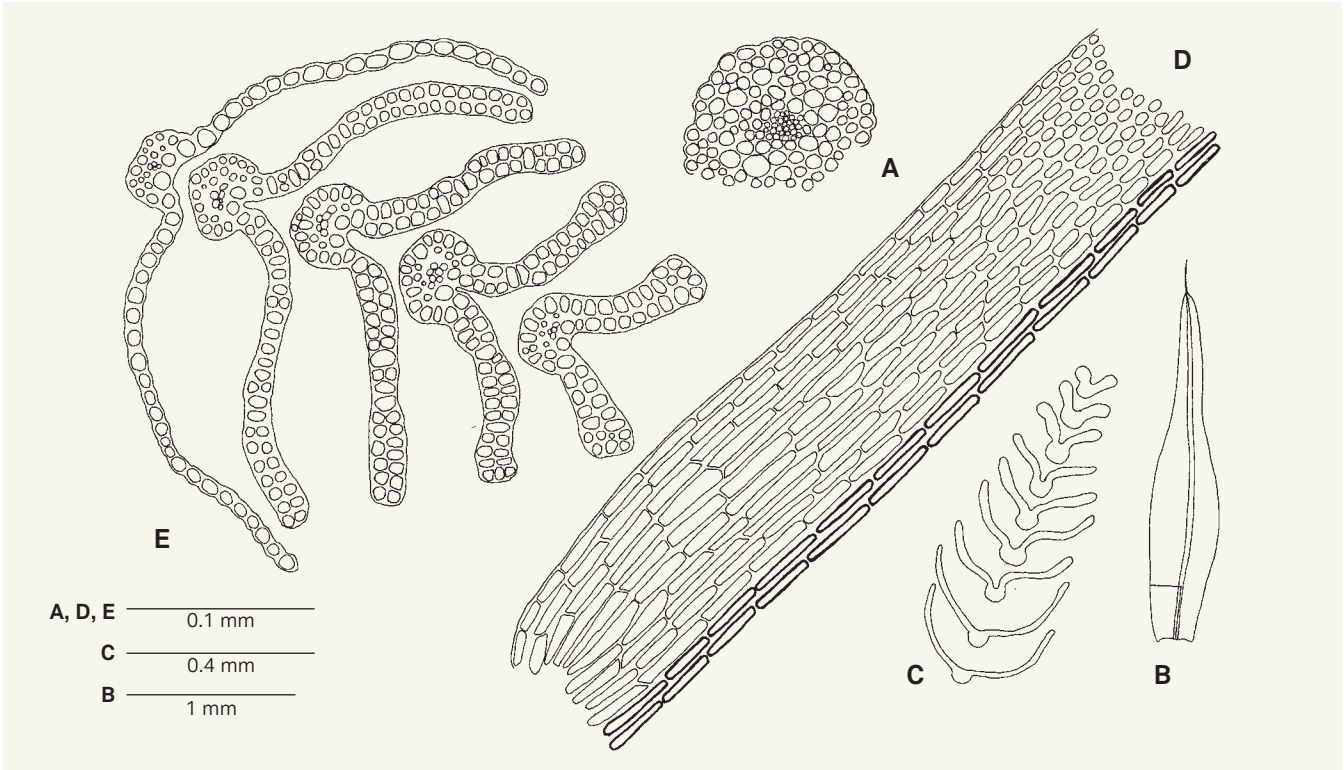

Fig. 4. – *Grimmia donniana* Sm.: **A.** Transverse section of stem; **B.** Leaf; **C.** Outlines of transverse section of leaf; **D.** Cells in leaf base and transitional part; **E.** Transverse section of leaf. [*Duckett, Hodgetts & Matcham 3274a*, Herb. Matcham]

some hyaline cells with finely sinuose walls, lower lamina cells short-rectangular, walls more or less sinuose, thickened, in upper laminal part cells mostly isodiametric, walls thickened, smooth or sinuose; seen in transverse section, lamina unistratose or bistratose in places, occasionally totally bistratose, margin unistratose in leaf base, in laminal part several rows bi- or tristratose. *Costa*, seen on dorsal side, small in leaf base, becoming gradually broader in laminal part, indistinct at apex, percurrent or excurrent, seen in transverse section, on dorsal side at insertion and in leaf base angulate or rounded, in laminal part rounded or occasionally prominent, on ventral side at insertion nearly plane, in leaf base widely channelled, in lower part of lamina channelled, in upper part narrowly so, at insertion and in leaf base 4 guide cells, from transitional part to apical part 2 guide cells, from insertion to upper laminal part a median group of hydroids, at insertion and in leaf base costal cells substereid.

Sporophyte. *Seta* of different lengths, 0.8-3.0 mm long, straight, occasionally curved, vaginula 0.8 mm long, cylindrical, ochrea broad. *Capsule* erect, horizontal at curved seta, ovoid, smooth, bright-coloured when mature, with age turning brownish, exothecial cells irregular, quadrate, hexagonal, elongate, thin-walled, seen in transverse section of capsule, exterior walls smooth, stomata large above capsule base, neck lacking, annulus of 2 rows of cells, if detaching then singly, seen in surface view cells round with small lumina. *Calyptra* mitrate, lobed, covering operculum. *Operculum* conical, mammillate, base smooth, cells rounded, thick-walled. *Peristome* teeth incurved or recurved when dry, broad at base, mostly entire at apex, separated down to insertion or at least to the lowermost plates, dorsal side in lower half covered with minute papillae, upper half of dorsal side and ventral side densely covered with fine papillae, trabeculae small, close together or distant, prominent in lower half, scarcely marked in upper part. *Spores* 8-9 μm, smooth.

Diagnostic characters. – Gametophyte. Leaf base with marginal rows of elongate-rectangular, hyaline cells, with longitudinal and transverse walls that are evenly thin, extending to broadest part of leaf (see Fig. 4D); margin never recurved; calyptra mitrate.

Distribution, habitat and ecology. – *Grimmia donniana* is disjunctively distributed in boreo-montane areas of the northern hemisphere, with extensions southwards in alpine areas. This species is also known in the southern hemisphere from New Zealand, southern Africa and Bolivia.

In South Africa and Lesotho (Fig. 1C) *G. donniana* is rare and known only from two high-altitude (> 3,000 m) sites in Lesotho, where it occurs on basalt in alpine grasslands.

Specimens examined. – **Lesotho:** Leribe, slopes and cliffs N of Bokong Headwaters, 3100 m, 29°5'S 28°21'E, 16.I.1995, *Duckett, Hodgetts & Matcham 3274a* (herb. Matcham); Kotisephola Pass, between Sani Top and Mokhotlong, 3240 m, II.1987, *van Rooy 3407* (PRE).

3. ***Grimmia elongata*** Kaulf. in J. Sturm, Deutschl. Fl. II(15): tab. 14. 1816 (Fig. 5).

Lectotypus (designated by Geissler & Maier, 1995: 500): **Austria:** "In Styria alpibus", s.d., *Kaulfuss s.n.* (B!; isolecto-: BM [BM000867904] image seen, G [G00052982]!).

Gametophyte. *Dioicous. Female:* innermost perichaetial leaf 2.8-3.5 mm long, sheathing up to mid-leaf, from ovate, elongated base constricted above mid-leaf to narrow upper part, leaf base hyaline, some rows of hyaline cells vanishing above broadest part, costa stout, excurrent into short, weakly denticulate hair-point; *male:* plants in separate cushions, perigonia as small buds on short stalks in leaf axils, several per stem, innermost perigonial leaf 0.7 mm, sheathing, ovate, strongly keeled, apex muticous, acute, hyaline up to broadest part, costa percurrent, paraphyses few. *Growth form*: cushion dense, disintegrating easily, young shoots originating from older stems, leaflets muticous, appressed to stem, plants somewhat radiculose at base, erect, branched, stem up to 40 mm high, thin, central strand poorly developed, occasionally lacking. *Leaves* 1.2-1.8 mm long, imbricate, in short-leaved form appressed to stem, in long-leaved form slightly twisted and loosely disposed on stem when dry, bending backwards when moistened, leaf base appressed to stem, laminal part patent, from narrow oval leaf base elongate-lanceolate, straight or somewhat falcate, on one side above broadest part markedly narrowed to apical part, thus forming shoulder, on nearly straight side margin recurved from leaf base up to mid-leaf, short leaves muticous, slightly cucullate, longer leaves apiculate, hair-point short, smoothly denticulate; *leaf form in situ*, at insertion and leaf base concave, at transitional part lamina spreading from costa, lower laminal part keeled, upper part narrowly so, margin at one side from insertion up to mid-leaf recurved; basal cells elongate-rectangular, walls smooth except some cell rows between margin and paracostal cells with faintly nodulose walls, at margin 3-4 rows narrowly elongate-rectangular, hyaline, thin-walled cells, gradually vanishing, outermost row ascending up to above broadest part of leaf, cells becoming short-rectangular to quadrate, walls more or less sinuose, in upper laminal part oval to isodiametric, lumina rounded, walls thickened; seen in transverse section, leaf base unistratose, lamina in places or entirely bistratose, margin unistratose at leaf base, in laminal part some cell rows bi- or tristratose. *Costa*, seen on dorsal side, weak at leaf base, stout in laminal part, reaching apex, in upper part dorsal cells similar in shape to proximate lamina cells, seen in transverse section, costa on dorsal side rounded at insertion and leaf base, occasionally prominent in laminal part, in rare cases

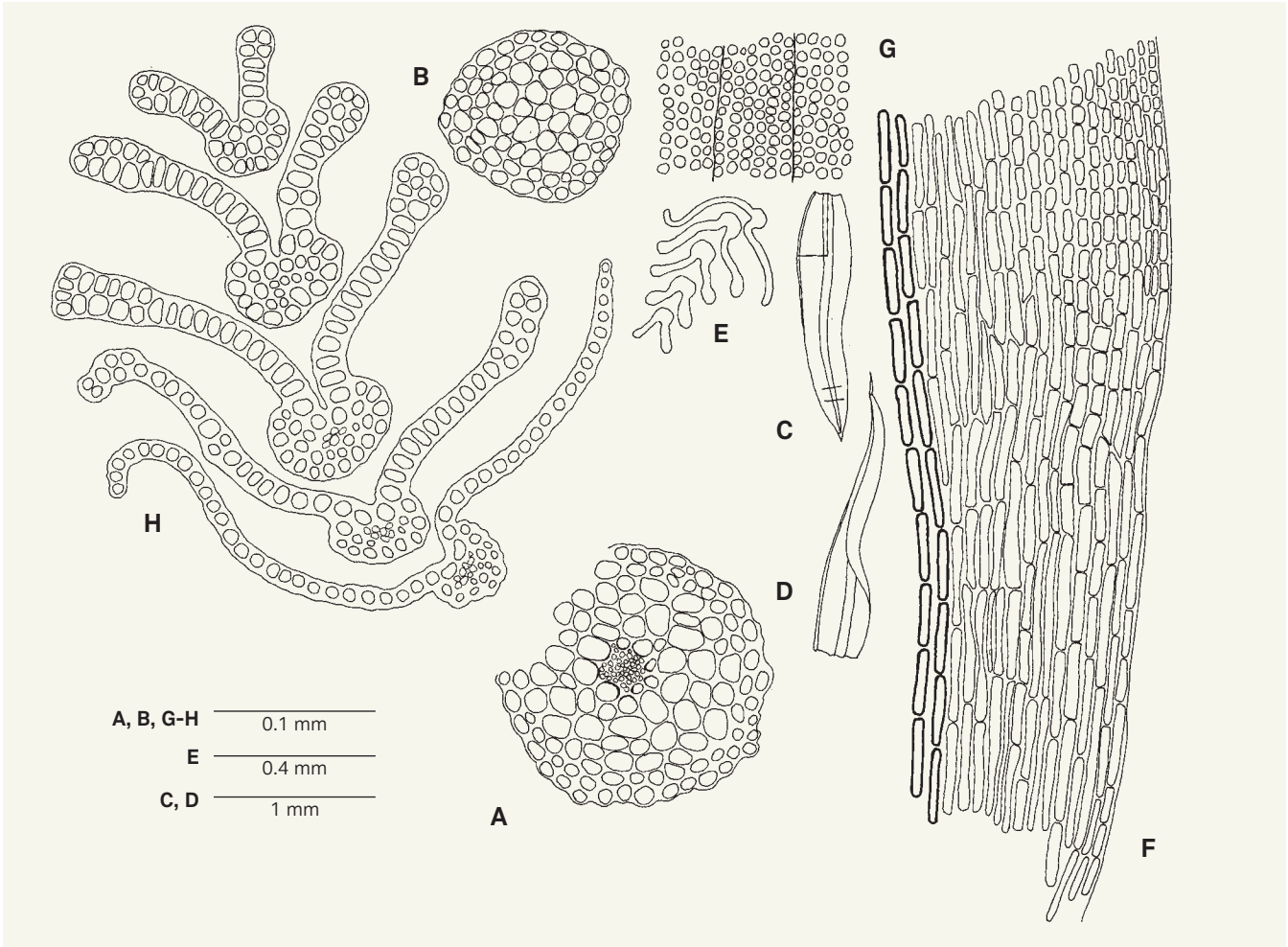

Fig. 5. – *Grimmia elongata* Kaulf. **A.** Transverse section of stem, with central strand; **B.** Transverse section of stem, without central strand; **C**, **D.** Leaves; **E.** Outlines of transverse section of leaf; **F.** Cells in leaf base and transitional part; **G.** Dorsal cells of costa in apical part; **H.** Transverse section of leaf. [**A, B, E:** *Hedderson 15449,* BOL; **C**, **F:** *Hedderson 15448,* BOL; **D, H:** *Hedderson 15455,* BOL; **G:** *Matcham 1094a,* herb. Matcham]

faintly mammillose, on ventral side at insertion and leaf base widely channelled, in middle part of lamina narrowly so, keeled in apical part, at insertion and leaf base 4 guide cells, in laminal part 2 guide cells, at insertion and leaf base substereids, in upper part cells rounded, homogeneous, hydroids from insertion up to mid-leaf.

Sporophyte. *Seta* erect, inclined or arcuate, 2.0-3.5 mm long, vaginula 0.8-1.2 mm long, cylindrical, ochrea small. *Capsule* emergent, erect, inclined or cernuous, ovoid or obloid, smooth, exothecial cells of variable shape, isodiametrically or elongated penta- and hexagonal, walls curvilinear, slightly thickened, stomata more or less numerous at capsule base, annulus of 2-3 rows of cells detaching singly, the lumen narrow, round. *Calyptra* mitrate-cucullate. *Operculum* conical, blunt, margin smooth of two rows of rounded cells, in conical part ovate, walls thickened. *Peristome* teeth erect or recurved when dry, broad at base, rarely slit or perforate, inner and upper outer side covered with rough, rounded and sharp papillae, lower outer side sparingly ornamented with fine papillae, trabeculae thin, scarcely protruding in lower part, conspicuously protruding in upper part. *Spores* 12-16 µm, granulose.

Diagnostic characters. – Gametophyte. Leaves with margin recurved on one side, with several marginal rows of elongate-rectangular, thin-walled, hyaline cells, reaching from insertion to above the broadest part of leaf, vanishing gradually, outer row ending in short-rectangular to quadrate cells. Costa, in upper part, dorsal cells similar in shape to proximate lamina cells.

Distribution, habitat and ecology. – *Grimmia elongata* is disjunctively distributed in mountains of the northern hemisphere with sporadic southwards extensions through the Andes, and central, eastern, and southern Africa.

In South Africa and Lesotho *G. elongata* (Fig. 1C) is disjunctively distributed between a few high altitude (2,200-3,250 m) localities in the Drakensberg and a single high summit (the Matroosberg) in the SW Cape. Known from basalt as well as from hard, nutrient-poor, quartzitic sandstones.

Notes. – All specimens seen from the study area are sterile. In this species the stratosity of the lamina and margin is variable. The leaf base is unistratose, with the lamina partly bistratose, to a varied extent. The margins may also be tristratose.

Selected specimens examined. – **South Africa. Prov. Western Cape:** Ceres - De Doorns Area, Matroosberg NR, Summit, 2200 m, 33°23'05"S 19°40'01"E, 9.XII.2003, *Hedderson 15448, 15449*; *ibid. loc., Hedderson 15455* (BOL). **Lesotho:** Butha-Buthe Distr., 20 km SE of New Oxbow Lodge on the road to Mokhotlong, 3250 m, 28°49'S 28°43'E, 15.IV.1994, *Matcham 1094a* (herb. Matcham).

4. ***Grimmia fuscolutea*** Hook., Musci. Exot. 1: 63. 1818 (Fig. 6).

Lectotypus (designated by Muñoz & Pando, 2000: 31). **South America:** *sine loc*, s.d., *Humboldt 50* [H 2673] (BM [BM000670173]!; isolecto-: BM000535435!).

= *Grimmia sanii* Greven, in Bryologist 99: 429. 1996. **Typus: South Africa. Prov. Natal:** Crows' Nest. Mount aux Sources, 3048 m, VII.1947, *Schelpe 2115* (holo-: PRE!; iso-: BOL! [3 packets filed under *G. pulvinata* (Hedw.) Sm.]), synonymized by Muñoz (1999: 138).

Gametophyte. *Monoicous*. *Female:* innermost perichaetial leaf up to 3.8 mm long, sheathing in lower part, shape and cell pattern as in stem leaves, lower third hyaline, costa excurrent to elongated, denticulate, slightly decurrent hair-point; *male:* perigonia below perichaetium in leaf axil as bud on short stalk, innermost perigonial leaf 0.8 mm long, slightly sheathing, ovate, apex rounded or obtuse, hyaline up to 2/3 of leaf length, costa percurrent, paraphyses short, few. *Growth form:* cushion compact, adherent to substrate with rhizoids, from where the young shoots originate, leaflets patent, muticous, apex acute, plants erect, branched in upper part, rhizoids in leaf axils, stems up to 15 mm high, central strand well-developed. *Leaves* up to 1.5 mm long, crowded, imbricate, appressed to stem and somewhat contorted when dry, slowly spreading when moistened, erecto-patent and stiff when wet, from ovate base lanceolate or broad-lanceolate, slightly asymmetric, tapering to acuminate apex, hair-point of different length, smoothly denticulate; *leaf form in situ*, concave at leaf base, with a more or less expressed plica near the costa on one side, and another one in the middle of the lamina on the other side, keeled in lower laminal part, narrowly keeled in upper laminal part, margin recurved or revolute on larger side from leaf base up to laminal part, on other side more or less recurved, in upper part both sides plane; all basal cells elongated, walls smooth or nodulose, thin- or thick-walled, at margin two or three rows of hyaline cells, vanishing above leaf base, in transitional part and lower half of lamina cells rectangular, walls strongly or weakly sinuose, arranged as strict, perpendicular rows parallel to costa, upper cells short-rectangular, walls sinuose; seen in transverse section, leaf base unistratose, laminal part unistratose, bistratose in places, apical part partly bistratose, in laminal part one or two marginal cell rows bistratose, dorsal and ventral exterior cell walls scarcely or distinctly bulging or occasionally with joint thickenings. *Costa*, seen on dorsal side, at insertion and leaf base weak, enlarged in laminal part, excurrent to hair-point, in muticous leaves vanishing below apex, seen in transverse section, costa on dorsal side at insertion and in leaf base rounded, in laminal part prominent, mammillose, on ventral side channelled, narrowly so in upper part, at insertion and leaf base 4 ventral cells, 2 median ones are guide cells, the 2 outer ones belong partly to basal paracostal cells, above broadest part of leaf reduced to 2 narrow elliptical guide cells, obliquely arranged to leaf axis, at insertion and leaf base a median group of hydroids or stereids, transformed to substereids in upper laminal part, vanishing in apical part.

Sporophyte. *Seta* arcuate, up to 2.5 mm long, vaginula 0.8 mm long, cylindrical, ochrea small. *Capsule* emergent, horizontal or pendent, ovoid, of various size, with apophysial part, plicate, in mature state nearly smooth, constricted below orifice, exothecial cells irregularly elongated, pentagonal, walls curvilinear, thin or thick (depending on focussing), stomata large, numerous at apophysis, annulus of 3-4 cell rows, detaching as spirals. *Calyptra* mitrate, lobed, covering operculum. *Operculum* conical, beak obtuse of variable length, margin smooth, some marginal rows of rounded or short-rectangular cells, in conical part cells rounded-rectangular, thin-walled. *Peristome* teeth spreading when dry, lanceolate, broad at base, perforated longitudinally or slit into two branches, at dehiscence joined at base, separating subsequently, lower dorsal side covered with prickly papillae, upper dorsal and ventral sides densely covered with pointed papillae, trabeculae thin, in upper part distant, scarcely protruding. *Spores* 10-12 µm, granulose.

Diagnostic characters. – Gametophyte. Leaves basally plicate on one side near the costa (Fig. 6C), basal cells elongated (Fig. 6D). In transverse section, costa with small, elliptical guide cells oriented obliquely to leaf axis in laminal part.

Distribution, habitat and ecology. – Disjunctively distributed, *Grimmia fuscolutea* is known in the northern hemisphere from the European Alps, and from scattered localities in the

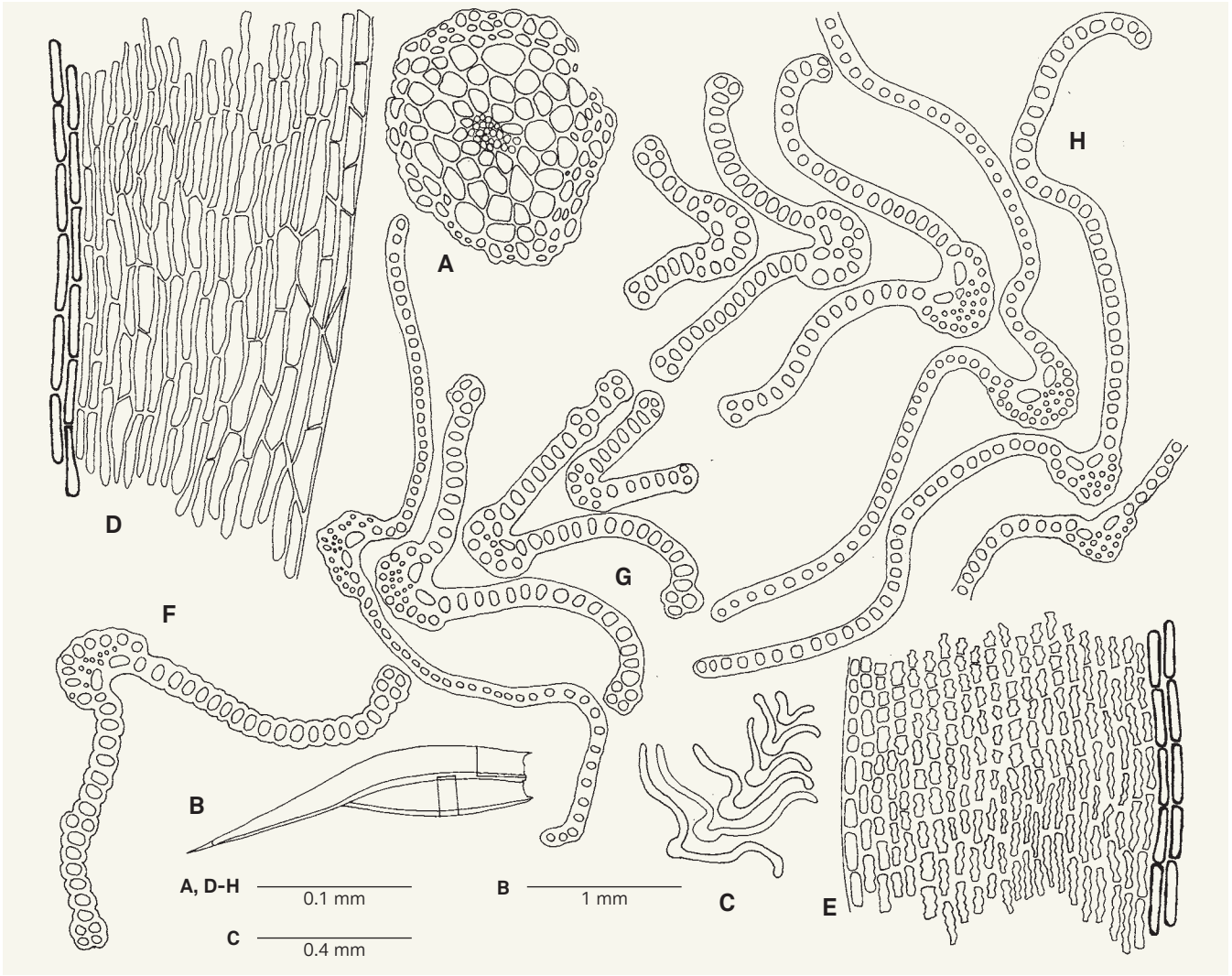

Fig. 6. – *Grimmia fuscolutea* Hook. **A**, Transverse section of stem; **B**, Leaf; **C**. Outlines of transverse sections of leaf; **D**. Cells in leaf base; **E**. Cells in transitional part; **F, G, H**. Transverse sections of leaves.
[**A-E, H:** *Hilliard & Burtt 7115*, BOL; **F:** *Schelpe 7682*, BOL; **G:** *Schelpe 2115*, PRE]

Himalaya (India, Nepal) and from Japan. In the southern hemisphere this species occurs along the South American Andes as far north as Mexico and in Africa from South Africa and Reunion Island.

In South Africa and Lesotho (Fig. 1D), *G. fuscolutea* occurs in mid- to high-altitude sites (730-3,370 m) from the northern Cederberg, south through the Cape Fold Mountains, and eastward along the Great Escarpment (where it is known from only three localities), to the Drakensberg. It grows on hard, quartzitic sandstones, basalt or dolerite in fynbos and grassland habitats.

Notes. – A total of 32 specimens were seen, 17 with sporophytes but only one with a capsule in a suitable state for examination.

Selected specimens examined. – **South Africa. Prov. Natal:** Underberg, Distr. Sani Pass, 8.XI.1973, *Hilliard & Burtt 7115* (BOL). **Orange Free State Prov.** Witzieshoek, base of Sentinel, 2740 m, *Schelpe 7682* (BOL).

5. ***Grimmia kidderi*** James in Bull. Torrey Bot. Club 6 : 54. 1875 (Fig. 7).

Lectotypus (designated by Muñoz, 1999 : 143) : **France. French Southern and Antarctic Territories :** Kerguelen Island, 1874, *Kidder s.n.* (FH! ; isolecto :- FH!).

Gametophyte. *Dioicous. Female :* innermost perichaetial leaf up to 4 mm long, slightly sheathing up to shoulder at mid-leaf, costa stout, excurrent to scarcely denticulate hair-point ; *male :* perigonia not seen. *Growth form* : cushion dense, adherent to substrate with grayish, in wet state hyaline, rhizoids, interwoven with young shoots, originating from older stem parts, leaflets scale-like, concave, muticous or with a hyaline end cell, in dry state firmly appressed to stem, apices spreading, producing bristly aspect, plants erect, sparsely branched, stems up to 10 mm high, central strand small. *Leaves* from lower part of stem 0.3-0.5 mm long, concave, muticous, becoming progressively longer, up to 1.7 mm long, loosely arranged to stem, erect when dry, moving weakly when moistened, erect or erecto-patent when wet, from ovate leaf base narrowly lanceolate, tapering to obtuse apex, muticous or with hair-point of different length, bluntly denticulate ; *leaf form in situ*, from insertion up to apical part concave or above broadest part of leaf widely keeled, in apical part keeled, margins plane throughout ; basal paracostal cells elongate-rectangular, thick-walled, more or less nodulose, towards margin rectangular, becoming short-rectangular to quadrate in transitional part, walls smooth, thickened, especially the transverse walls, cells in laminal part isodiametric, lumina rounded ; seen in transverse section, leaf base unistratose, in lower laminal part uni- to bistratose, apical part bistratose, occasionally with tristratose marginal cell rows. *Costa*, seen on dorsal side, of even width throughout, not reaching apex, seen in transverse section, costa rounded, on ventral side widely channelled, in upper part of leaf channelled or narrowly channelled, at insertion and leaf base 4 guide cells, in laminal part 2, with hydroids.

Sporophyte. *Seta* slightly curved, 1.2 mm long, vaginula 0.6 mm long, with ochrea. *Capsule* hidden in the leaves, ovoid, smooth, after spore release enlarged at orifice, exothecial cells elongated, walls thick, in surface view strongly thickened, stomata rare in capsule base, annulus disintegrating in fragments. *Calyptra* not seen. *Operculum* conical, beak long, oblique, smooth at margin, all cells rounded, thick-walled. *Peristome* teeth reflexed in dry state, entire, on inner and upper outer side densely ornamented with sharp papillae, the lowest outer plates finely and sparingly papillose, trabeculae close together, small, scarcely protruding. *Spores* 10-13 µm, finely granulose.

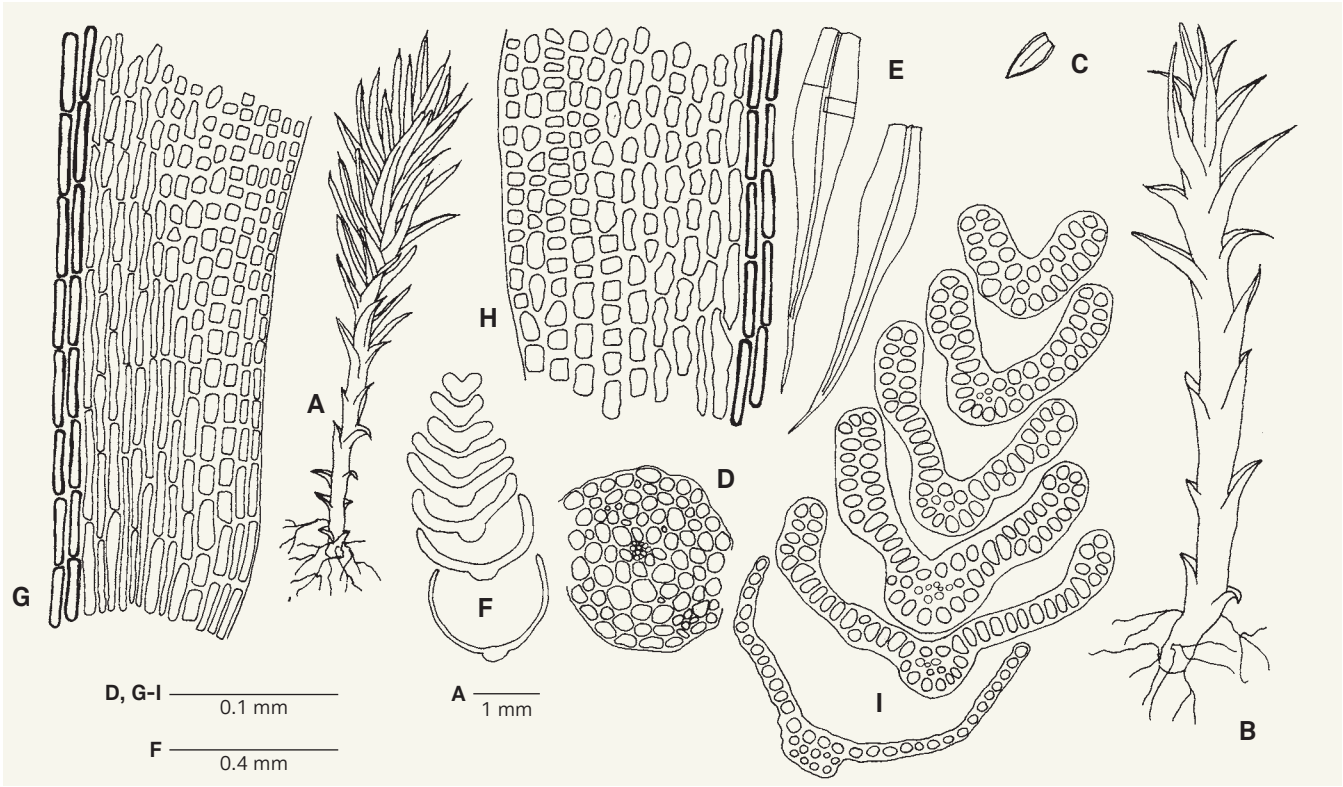

Fig. 7. – *Grimmia kidderi* James **A.** Plant ; **B.** Young shoot ; **C.** Leaflet of young shoot ; **D.** Transverse section of stem ; **E.** Leaves ; **F.** Outlines of transverse section of leaf ; **G**, Cells in leaf base ; **H.** Cells in transitional part ; **I.** Transverse section of leaf. [**A-C:** *Hedderson 13724*, BOL ; **D-G**, **I:** *Hedderson 13081*, BOL ; **H:** *Hedderson 13744*, BOL]

Diagnostic characters. – Gametophyte. Perichaetial leaves markedly longer than vegetative leaves; leaves narrowly lanceolate, concave nearly throughout, margins plane. Sporophyte. Capsule immersed.

Distribution, habitat and ecology. – *Grimmia kidderi* is a southern-temperate species recorded from Argentina, Chile, the Kerguelen Islands, Ascension Island, Tristan da Cunha and South Africa.

In South Africa and Lesotho *G. kidderi* is rare and currently known only from two localities on the high summits of the northern and middle Cederberg from 1,150-1,870m, as well as from a single locality on the Great Escarpment of the Eastern Cape Province (Fig. 1E). This species is found in fynbos with outcropping sandstone, and on sandstone cliffs and seasonally wet rock slabs. Whilst apparently genuinely rare in the west, it may be under-collected in the eastern part of its range.

Notes. – The four specimens seen were sterile. The description of the sporophyte herein is based on *Skottsberg 371* (H-BR) from the Patagonian region of Argentina (Maier, 2010: 180). The stratosity of the lamina in this species is variable. Some collections of *G. kidderi* from the study area have bulging cells with hyaline outer walls on the dorsal surface of the leaves. This phenomenon is not restricted to this species and seems to be due to harsh conditions under which the plants are growing.

Selected specimens examined. – **South Africa. Prov. Western Cape:** Cederberg. Zuurvlakte, 1150 m, 32°36'32"S 19°12'12"E", 27.II.2000, *Hedderson 13081* (BOL); Citrusdal Region, Cederberg State Forest, E side of Langberg, and slopes of Shadow Peak, 1550-1870 m, 32°23'20"S 19°10'25"E, 17.II.2001, *Hedderson 13724* (BOL); *ibid. loc., Hedderson 13744* (BOL).

6. ***Grimmia laevigata*** (Brid.) Brid., Bryol. Univ. 1: 183. 1826 (Fig. 8).

≡ *Campylopus laevigatus* Brid., Muscol. Recent. Suppl. 4: 76. 1819.

Lectotypus (designated by Cao & Vitt, 1986: 181): **Italy:** *sine loc.*, s.d., *Anon. s.n.* (B!).

= *Grimmia senilis* Shaw in Cape Monthly Mag. 17: 380. 1878. **Typus: South Africa. Prov. Cape:** Dry karroo dyke on bare rock, Longhope Cookhouse, 900 m, IV.1921, *Sim 9956* (holo-: PRE!), synonymized by Magill (1981: 277).

Gametophyte. *Dioicous. Female:* innermost perichaetial leaf up to 2 mm long, sheathing up to broadest part of leaf, narrowed at leaf base, ovate to broad-ovate, lower half hyaline or only some rows of hyaline cells at margin, vanishing at mid-leaf, costa obscure in apical part, excurrent in long, denticulate hair-point; perigonia as multifoliose buds at tips of branches; *male:* innermost perigonial leaf up to 1 mm long, sheathing, broad-ovate, suddenly narrowed to acute apex with hyline cell, hyaline in lower part, costa vanishing below apex, paraphyses short, numerous. *Growth form*: cushion lax, young shoots mostly present, originating from decomposing plants, with scale-like leaflets appressed to stem, costa vanishing below acute apex, with sharply pointed hyaline cell or short hair-point; plants erect, scarcely branched, slightly radiculose at base, stems up to 20 mm high, central strand well-developed. *Leaves* in lower part of stem scale-like, becoming gradually longer to tip of stem, 1.2-1.8 mm long, rarely up to 3 mm long, imbricate, appressed to stem when dry, older leaves bending backwards when moistened, younger leaves moving slightly, erect or spreading when wet; from short (~1/5 of leaf length), rounded, half-sheathing, slightly decurrent leaf base, lingulate or broad-lanceolate, tapering to obtuse or rounded, even acute apex, hair-point roughly denticulate, occasionally nearly smooth; *leaf form in situ*, widely concave or concave throughout, margin plane; some rows of basal paracostal cells rectangular, walls smooth or faintly nodulose, towards margin in sheathing part cells isodiametric or transversely rectangular or oval, transverse walls thicker than longitudinal walls, in laminal part cells homogeneous, rounded, walls thick; leaf base, seen in transverse section, unistratose, in transitional part bistratose in places, in laminal part bi- to tristratose, at margin from insertion up to apical part one or more cell rows unistratose, in apical part at least one side unistratose, at apex bistratose. *Costa*, seen on dorsal side, at leaf base large, from above widest part of leaf up to apex indistinct, excurrent, in laminal part dorsal cells not different from lamina cells, seen in transverse section, on dorsal side at insertion and lower part of leaf flat, weakly convex, at upper part slightly rounded, on ventral side at leaf base widely channelled, in upper part narrowly so, at insertion and leaf base from 7 to 11 ventral cells, most of them guide cells, a small median band of substereids, interrupted by 3 groups or one large central group of hydroids, substereids and hydroids vanishing in apical part, in transitional part number of guide-cells reduced to 4, in laminal part with 2 guide cells, sunken into narrow channel, adaxial cell walls strongly thickened.

Sporophyte. *Seta* up to 3 mm long, straight, vaginula 1 mm long, cylindrical. *Capsule* emergent, obloid, smooth, exothecial cells elongated, of variable shape, slightly curvilinear, stomata in short neck, annulus of three rows of cells, detaching spirally in groups. *Calyptra* mitrate, in upper part brownish, lobed, covering upper part of capsule. *Operculum* conical, beak straight, blunt, margin uneven or crenulate, one or two marginal rows of rounded cells, in conical part irregular, walls thickened, curvilinear, faintly nodulose. *Peristome* teeth erect when dry, broad at base, slit half way down to two or three

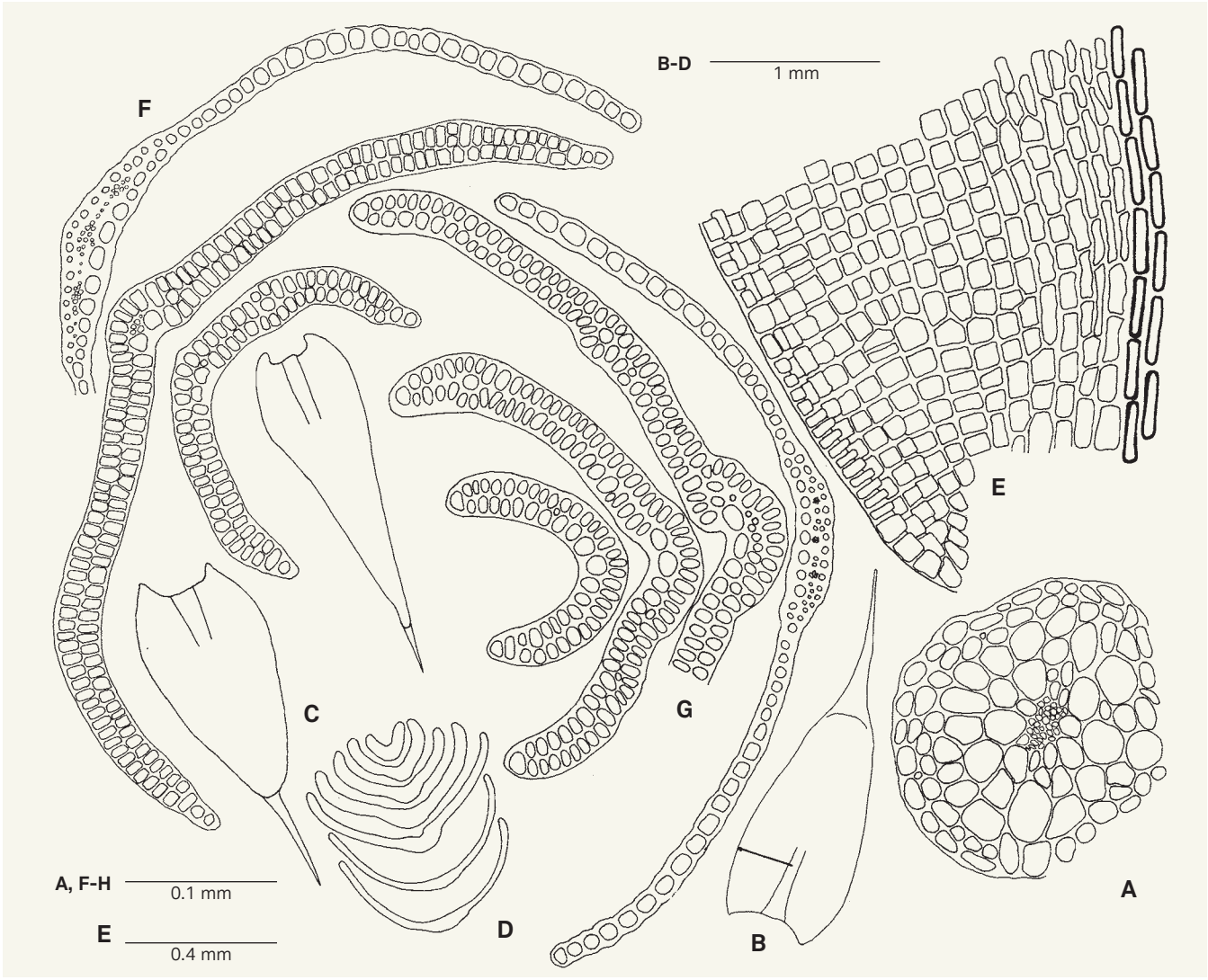

Fig. 8. – *Grimmia laevigata* (Brid.) Brid.: **A.** Transverse section of stem; **B**, **C.** Leaves; **D.** Outlines of transverse section of leaf; **E.** Cells in leaf base; **F, G.** Transverse sections of leaves.
[**A, C, D-F:** *Hedderson 13782,* BOL; **B:** *Hedderson 13219,* BOL; **C**, **G:** *Lübenau SA 62,* STU]

branches or perforate, lower dorsal side smooth, upper dorsal and ventral sides sparingly to densely covered with rounded papillae, trabeculae broad, distant, protruding, in upper third thin. Mature IX. *Spores* 12-16 µm, smooth.

Diagnostic characters. – Gametophyte. Leaves scale-like on young shoots and from lower part of stem with short hair-point or at least with a sharp hyaline end cell (Figs. 8B-D); base of stem leaves short, rounded, half-sheathing, at margin from insertion up to apical part one or more unistratose cell rows. Costa with hydroids, in upper part of leaf with 2 guide cells sunken into a narrow channel, their adaxial cell walls strongly thickened (Fig. 8H), a specific character of *G. laevigata*. Sporophyte. Peristome teeth slit or perforated.

Distribution, habitat and ecology. – *Grimmia laevigata* is widespread across temperate areas of the globe, with extensions into the tropics, and it occurs on all continents except Antarctica. This species is very common in arid and semi-arid zones, and especially in regions with a Mediterranean-type climate. In Africa it is common across the desert and semi-desert areas, and also occurs on higher summits in tropical regions, but it is apparently absent from west- and central-tropical Africa.

In South Africa and Lesotho, *G. laevigata*, along with *G. pulvinata*, is one of the most widespread species in the study area where it has been recorded from all the major biomes (Fig. 1F). It is especially common on shale substrates throughout the various types of karoo vegetation, occurring from 80 m to 2,250 m.

Notes. – A total of 133 specimens were seen. Of these 16 had sporophytes, 5 of which had capsules that were in good condition. The leaf form and length are very variable, the hair-point is short or elongate, sharply and densely denticulate, rarely nearly smooth. The normally bi-stratose lamina may show partially tristratose patches. In rare cases the costa may be overlaid ventrally by supplementary cells on one side or both sides of the leaf axis, thus covering the guide cells.

A specimen of *G. laevigata* that is cited in Dixon & Gepp (1923) is housed in PRE as "G. campestris Burchell [ex Hook.], no. 135, coll. Rehmann, Cape Town, s.d.".

Selected specimens examined. – **South Africa. Prov. Northern Cape:** Namaqualand, Richtersveld Mountains, Khubus, narrow valley running east of town below Vandersterrberg, 28°25'09"S 17°02'38"E, up to c. 800 m, 23.IV.2000, *Hedderson 13219* (BOL, G). **Prov. Western Cape:** Koue Bokkeveld Mountains, Twee Riviere, Suikerbossie Farm, c. 900 m, 32°40'30"S 19°16'02"E, 7.IV.2001, *Hedderson 13782* (BOL); c. 6 km von Clanwilliam dam, c. 200 m, 7.IX.1990, *Lübenau SA 62* (G, STU).

7. ***Grimmia longirostris*** Hook., Musc. Exot. 1: 62. 1818 (Fig. 9).

Lectotypus (designated by Deguchi, 1984: 21): **Ecuador:** *sine loc.*, s.d., *Humboldt 76* [H 2669] (BM [BM000671051]!; isolecto-: BM [BM000670951]!).

Gametophyte. *Mostly monoicous. Female:* innermost perichaetial leaf up to 4 mm long, sheathing up to 2/3 of leaf length, leaf base elongated, in broadest part suddenly narrowed to subulate apical part, at margin, from insertion up to broadest part of leaf, a broad band of hyaline cells present, vanishing gradually in upper leaf, costa excurrent in denticulate hair-point; *male:* perigonia not seen. *Growth form:* in dense cushions, adherent to substrate with rhizoids, from which young shoots with scale-like leaflets originate, apices patent, muticous, acute, plants erect, branched, radiculose at base, stems up to 30 mm high, central strand well-developed. Lower *leaves* scale-like, upper stem leaves up to 3 mm long, loosely disposed on stem, apices may be contorted, imbricate when dry, bending backwards when moistened, erecto-patent when wet, from ovate base gradually narrowed to lanceolate lamina, tapering to acute apex, hair-point short, faintly to strongly denticulate; *leaf form in situ*, at base concave, one side plicate, in laminal part keeled, narrowly so below apex, margin on larger side from insertion up to mid-leaf recurved or revolute, other side mostly plane; basal paracostal cells elongate-rectangular, walls nodulose, thickened, transverse walls thin, often oblique, cells near margin quadrate to rectangular, walls smooth, transverse walls thickened, in some specimens hyaline up to broadest part of leaf, in transitional part paracostal cells short-rectangular, walls thickened, nodulose or smooth, upper lamina cells rounded-quadrate, walls thickened, faintly sinuose; seen in transverse section, basal cells unistratose, in transitional and lower laminal part uni- to bistratose, in upper part bistratose, at margin several rows of cells bistratose except at leaf base. *Costa*, seen on dorsal side, of nearly uniform breadth, slightly smaller at insertion, obscure in keeled part, percurrent, seen in transverse section, costa on dorsal side at insertion and leaf base widely rounded, in lower laminal part unevenly rounded, somewhat angulate, and slightly contracted at origin of lamina, becoming indistinct in upper laminal and keeled part, on ventral side at insertion and leaf base widely channelled, in laminal part channelled, at insertion and leaf base 6 guide cells, rarely only 4, in upper part 5 or 4, in indistinct part 2 guide cells, from insertion up to indistinct part a central band of stereids or substereids, occasionally a central group of hydroids, vanishing in upper part of leaf.

Sporophyte. *Seta* straight, 1-5 mm long, vaginula 0.9-1.2 mm long, cylindrical, with ochrea. *Capsule* exserted, emergent or immersed, erect, cylindrical, oblong-ovoid, with short neck, narrowed at orifice, smooth, in immature state shrivelled, exothecial cells multiform, elongated, walls curvilinear, stomata at transition above neck and at base of capsule, annulus of three or four rows of cells, detaching in a spiral. *Calyptra* mitrate, mostly with a single slit, covering upper third of capsule. *Operculum* rostellate, beak straight or slightly oblique, margin crenulate, one or two rows of rounded marginal cells, in conical part rhombic, rounded-rectangular, thick-walled. *Peristome* erect when dry, teeth lanceolate, entire or split into two or three branches, on dorsal side two or three plates smooth, the consequent dorsal part covered with fine papillae, the upper third of dorsal side and ventral side densely covered with conspicuous papillae, trabeculae small in lower part, thin in upper part. *Spores* 10-12 µm, smooth.

Diagnostic characters. – Gametophyte. Leaf apically keeled, margin recurved on broader side. Costa, in lower part of lamina, unevenly rounded, somewhat angulate.

Distribution, habitat and ecology. – *Grimmia longirostris* is a very widely distributed species that is often associated with montane or sub-montane habitats in temperate and arctic regions. This species is found on all continents except Antarctica. It also occurs widely throughout the tropics in higher mountain systems.

In South Africa and Lesotho (Fig. 2A) this species is restricted to the high Drakensberg (1,860-3,370 m) and associated ranges, where it occurs on basalt in high-altitude grasslands.

Notes. – A total of 56 specimens were seen, 16 with sporophytes but only 4 with capsules in a suitable state for examination, 3 were immature and 9 were decomposed. Misidentifications of this species appear largely to be responsible

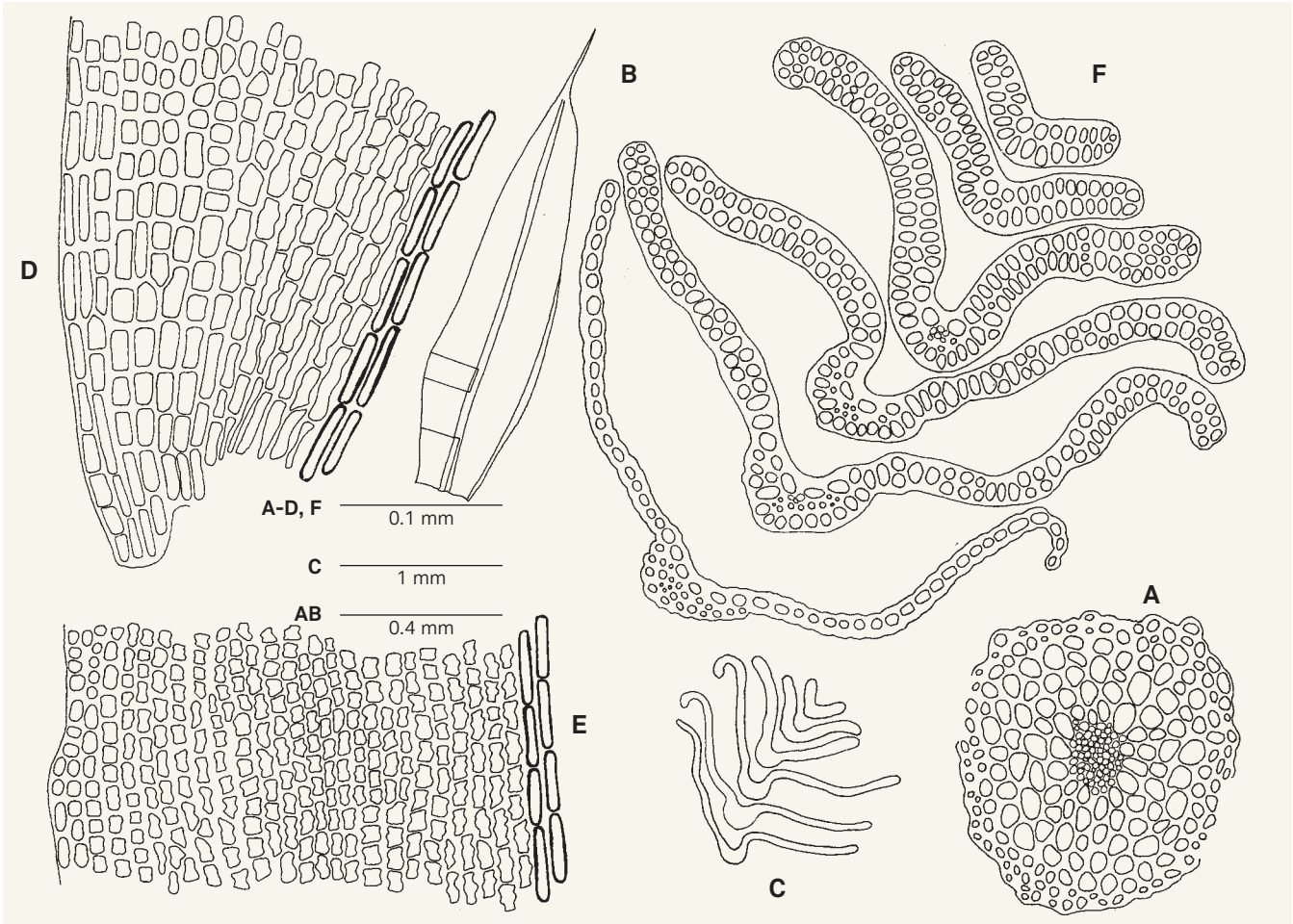

Fig. 9. – *Grimmia longirostris* Hook.: **A.** Transverse section of stem; **B.** Leaf; **C.** Outlines of transverse section of leaf; **D.** Cells in leaf base; **E.** Cells in transitional part; **F.** Transverse section of leaf.
[**A:** *Esterhuysen 21637,* BOL; **B-E:** *Schelpe 2116,* BOL; **F:** *Esterhuysen 35931,* BOL]

for the persistent records of *G. ovalis* (Hedw.) Lindb. from South Africa, (see under *Excluded species for South Africa and Lesotho* below). A syntype of *Grimmia longirostris* is extant at G [G00281576]).

Selected specimens examined. – **South Africa. Prov. Natal:** Bergville Dist., Mnweni area, Drakensberg, 2740 m, VII.1953, *Esterhuysen 21637* (BOL); Bethlehem Division, Drakensberg, Mont-aux-Sources, Crows' Nest, VII.1947, *Schelpe 2116* (BOL [3 specimens]); Drakensberg: Umgatsheni valley S aspect bank, c. 2130 m, s.d., *Esterhuysen 35931* (BOL).

8. ***Grimmia montana*** Bruch & Schimp. in Bruch et al., Bryol. Eur. 3: 128. 1845 (Fig. 10).

Lectotypus (designated by Cao & Vitt, 1986: 161): **Germany:** "Felsen auf dem Donnersberg", IV.1843, *Gümbel s.n.* (BM [BM000670468]!).

= *Grimmia argyrotricha* Müll. Hal. in Flora 73: 485. 1890. **Neotypus** (designated by Maier, 2010: 224): **Tanzania:** "Kilimandscharo, unter Schnee in Felsspalten nach W. vorspringendem Grat der Mawenzi-Spitze", 4600 m, 31.X.1893, *Volkens 1347* (H-BR!).

Gametophyte. *Dioicous. Female:* innermost perichaetial leaf 2.7-3.5 mm long, sheathing up to broadest part, at lower third of leaf cells transparent, some rows of hyaline marginal cells vanishing at broadest part, costa small at leaf base, stout in upper part, excurrent to long-excurrent and forming a

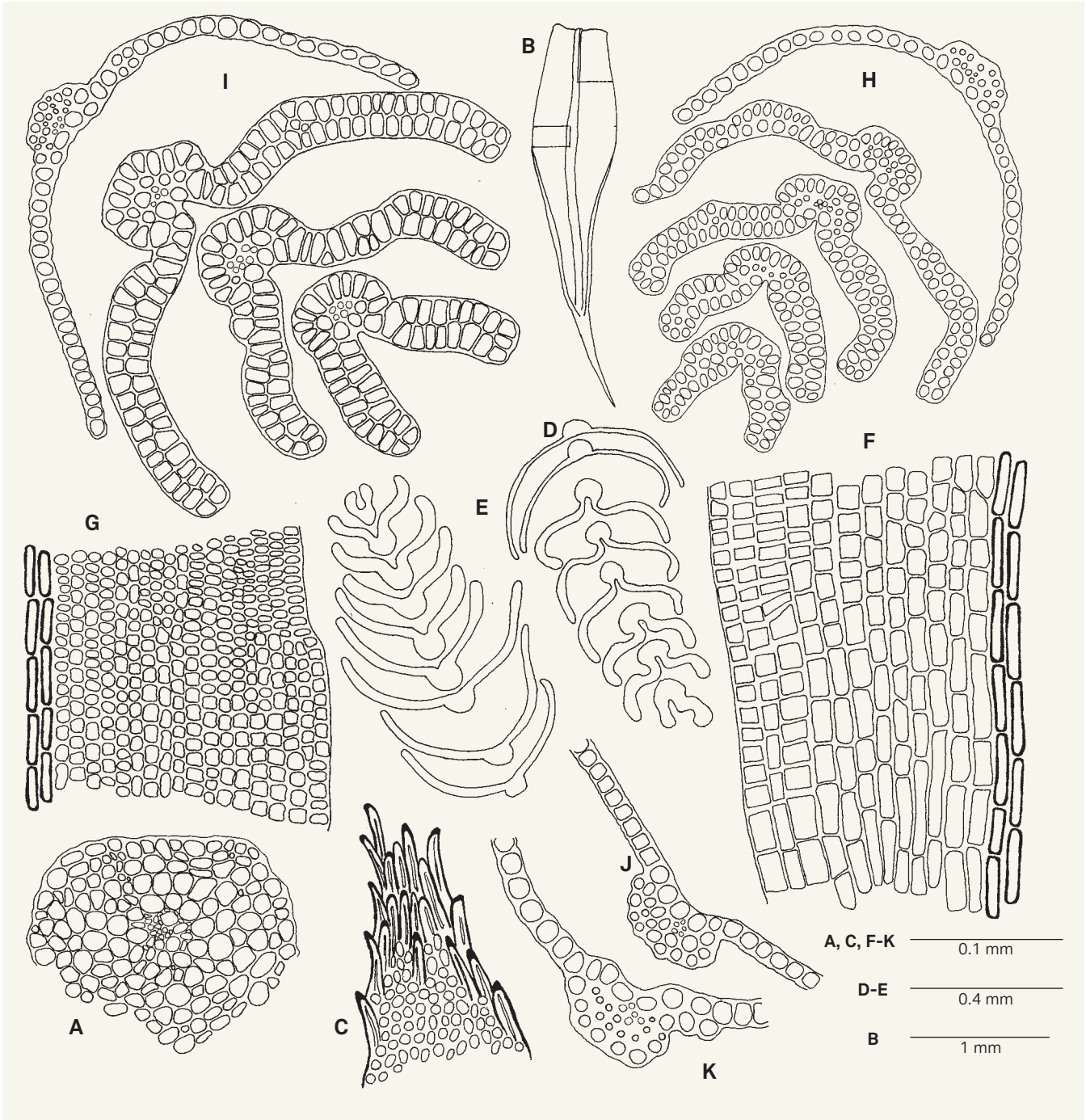

Fig. 10. – *Grimmia montana* Bruch & Schimp.: **A.** Transverse section of stem; **B.** Leaf; **C.** Hair-point; **D**, **E.** Outlines of transverse sections of leaves; **F.** Cells in leaf base; **G.** Cells at margin above shoulder; **H, I.** Transverse sections of leaves; **J, K.** Transverse sections of costae at insertion. [**A, C:** *Hedderson 13706*, BOL; **B**, **F**, **G**, **I:** *Hedderson 14491*, BOL; **D**, **J:** *Hedderson 14482*, BOL; **E:** *Hedderson 13645*, BOL; **H:** *Hedderson 14990*, BOL; **K:** *Hedderson 14501*, BOL]

denticulate hair-point; *male* plants in separate cushions, perigonia as multifoliose buds terminal or in leaf-axils, often several in one plant, innermost perigonial leaf 1 mm long, strongly sheathing, concave, apex acute or blunt, costa percurrent, paraphyses numerous. *Growth form*: cushion compact, interwoven with young shoots originating from rhizoids or older stem parts, leaflets appressed to stem, apices slightly patent, plants erect, radiculose at base, stems up to 20 mm high, central strand developed. Lower *leaves* small, muticous, suddenly longer, 1.8-2.5 mm long, lower part appressed to stem, apical part of longer leaves slightly twisted when dry, slowly bending backwards when moistened, erectopatent when wet, at transitional part from broad, ovate leaf base restricted to lanceolate laminal part, thus forming shoulder, tapering to acuminate apex, hairpoints of variable length, densely and bluntly denticulate; *leaf form in situ*, concave from leaf base up to upper part of leaf, upper third keeled, margins in laminal part from leaf base up to apical part gradually becomng plane or incurved; basal cells near costa rectangular, towards margin two or three rows of short-rectangular or quadrate cells, walls smooth, transverse walls markedly thicker than longitudinal walls, at margin some rows of hyaline cells, above shoulder at margin a longitudinal row of transversely oval cells, lamina cells small, more or less isodiametric, lumina rounded, lamina cells, seen in transverse section, short-rectangular, exterior cell walls smooth; leaf base unistratose, in transitional part lamina bistratose in places, in upper part bistratose, occasionally unistratose near costa, margin unistratose at leaf base, in laminal part bistratose, below apex occasionally tristratose. *Costa*, seen on dorsal side, small at leaf base, enlarged, prominent in laminal part, excurrent, costa, seen in transverse section, on dorsal side at leaf base rounded, in lower laminal part prominent, slightly angulate, in upper laminal part rounded, on ventral side at insertion widely channelled, in laminal part channelled or narrowly channelled, at insertion and leaf base 4 guide cells, occasionally enlarged to 5 cells, in laminal part reduced to 2, from insertion to mid-leaf with a central median group of hydroids, transformed to substereids in upper part, vanishing in apical part.

Sporophyte. *Seta* up to 3.5 mm long, straight, vaginula 0.8 mm long, cylindrical. *Capsule* emergent, erect, obloid, occasionally slightly asymmetric, smooth, exothecial cells mostly elongated, rarely pentagonal, walls thin or thick, depending on orientation and focusing, curvilinear, stomata none, at orifice several rows of transversely rectangular cells, the two upper rows suggesting a persistent annulus. *Calyptra* cucullate, covering part of capsule. *Operculum* conical, rostrate or rostellate, beak straight or oblique, blunt, margin uneven, some rows of small, rounded marginal cells, in conical part larger oval or rounded cells. *Peristome* teeth erect when dry, lanceolate, irregularly perforated or slit to two unequal branches, lower dorsal part smooth, subsequent plates sparsely covered with fine papillae, upper dorsal and ventral sides densely covered with fine papillae, trabeculae thin, in lower part close together, in upper part distant, slightly protruding. *Spores* 10-12 µm, smooth.

Diagnostic characters. – Gametophyte. Leaves with cells at basal margin short-rectangular to quadrate, with transverse walls strongly thickened, above shoulder margins with a row of transversely oval cells; in transverse section lamina cells short-rectangular, with exterior cell walls smooth; margins in laminal part plane or incurved.

Distribution, habitat and ecology. – *Grimmia montana* is widely, but highly disjunctively distributed. In the northern hemisphere, it occurs in the warm and dry western interior of North America, extending south to Mexico and north to a few localities in the Yukon and Alaska, and with a few localities in eastern Canada and Greenland. It also occurs in Europe and adjacent North Africa, including Macaronesia, western and central Asia, and Hawaii. In the southern hemisphere it occurs only in Africa (Tanzania and southern Africa) and New Zealand.

In South Africa and Lesotho (Fig. 2B) most of the known populations of *Grimmia montana* are on seasonally wet quartzitic sandstone, often on slabs that receive water from melting snow, in the higher peaks (mostly above 1,500 m, but rarely down to 1,300 m) in the Cape Fold Mountains from the Hantamsberg and Northern Cederberg, south and eastwards to the Swartberg. Two disjunct populations occur on basalt at high altitude (>3,200 m) in the Drakensberg. This species is also likely to be found on the higher peaks of the Great Escarpment in the Eastern Cape; these areas remain bryologically poorly explored.

Notes. – A total of 27 specimens were seen all of which were sterile. In female plants the basal cells may be elongated, and the loss of chlorophyll may give the leaf base a hyaline aspect. In the local specimens available for this study, no sporophytes were found in appropriate condition for the description of their characters.

The name *Grimmia argyrotricha* Müll. Hal. has been used in various works on the bryophyte flora of Africa, e.g. O'Shea (2006 : 92) and Van Rooy & Perold (2006 : 15). The type specimen of *G. argyrotricha*, collected by Dr. Hans Meyer in the Kilimandscharo Massif in 1880 was destroyed at B and a neotype has been selected by Maier (2010 : 232).

Selected specimens examined. – **South Africa. Prov. Western Cape :** Citrusdal Area, Cederberg Apex Peak area, 1500 m. 32°35'34"S 19°12'27"E, 9.I.2001, *Hedderson 13645* (BOL); Cederberg, Cederberg State Forest, E side of Langberg, 1550-1870 m 32°23'20"S 19°10'25"E, 17.II.2001, *Hedderson 13706* (BOL); Cederberg, Sneeuberg, Ridge to NW of main peak, 1500-1700 m, 32°29'58"S 19°08'51"E, 7.IV.2002, *Hedderson 14482* (BOL, G); *ibid. loc., Hedderson 14491* (BOL); *ibid. loc., Hedderson 14501* (BOL); Cederberg Wilderness Area, slopes on West side of Shadow Peak, 1850 m, 32°23'20"S 19°10'25"E, 22.II.2003, *Hedderson 14990* (BOL).

9. ***Grimmia orbicularis*** Wilson in Engl. Bot. Suppl. 4: n. 2888. 1844. Fig. 11.

Lectotypus (designated by Muñoz & Pando, 2000: 58): **United Kingdom. England:** St. Vincents Rocks, II.1837, *Eagle s.n.* (BM [BM000670185]!; isolecto:- BM [BM000670193]!).

= *Grimmia leptotricha* Müll. Hal. in Hedwigia 38: 120. 1899. **Lectotypus** (designated by Muñoz & Pando, 2000: 69). **South Africa:** "In monte 'Boschberg' prope Somerset-East, Promont. bon. Spei", s.d., *MacOwen s.n.* (BM [BM000575823]!).

Gametophyte. *Monoicous. Female:* innermost perichaetial leaf 1.8-2.0 mm long, sheathing to mid-leaf or two third of leaf length, concave, sheathing part transparent, costa stout in upper part, excurrent in broad, nearly smooth hair-point; *male:* perigonia in branches far below perichaetium as multifoliate buds on short stalks, the concave, hyaline lower part of innermost perigonial leaf sheathing, suddenly narrowed to acute apical part, costa vanishing below apex, paraphyses present. *Growth-form*: cushions dense, compact, strongly attached to substrate, stolons originating from mostly present tomentum, leaflets scale-like, appressed to stem, apices patent, plants erect, branched, stems to 30 mm high, central strand developed. *Leaves* 1.0-1.5 mm long, crowded, appressed to stem when dry, bending backwards when moistened, erecto-patent when wet, from ovate leaf base lanceolate or elongate-lanceolate, broadest at mid-leaf, tapering to obtuse apex, hair-point very short to elongated, nearly smooth; *leaf form in situ*, at base concave, laminal part keeled, margins on both sides from below to above mid-leaf recurved, rarely on one side only; basal paracostal cells elongate-rectangular, walls nodulose, at margin some cell rows

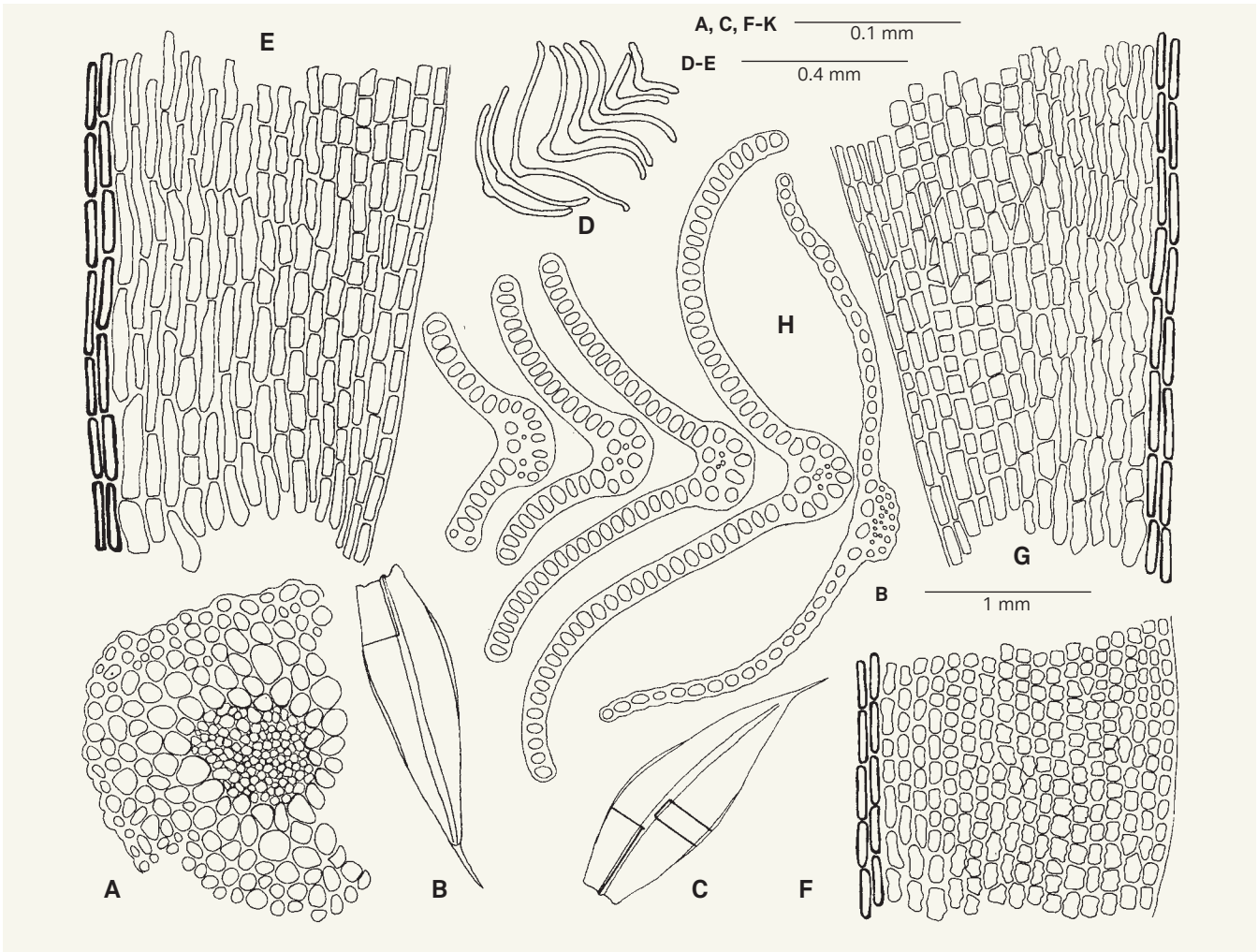

Fig. 11. – *Grimmia orbicularis* Wilson: **A.** Transverse section of stem; **B**, **C.** Leaves; **D.** Outlines of transverse section of leaf; **E**, **G.** Cells in leaf base; **F.** Cells in transitional part; **H.** Transverse section of leaf.
[**A:** *Hedderson 15285*, BOL; **B**, **E:** *MacOwen s.n.*, BM; **C**, **F-H:** *Hedderson 15264*, BOL; **D**, *Hedderson 13047*, BOL]

rectangular to quadrate, transverse walls thickened, smooth, cells in transitional part short-rectangular, sinuose, in upper laminal part isodiametric, lumina rounded; seen in transverse section, leaf base and lamina unistratose throughout, margin unistratose except one bistratose cell row on one, rarely on both sides near apex. *Costa*, seen on dorsal side, narrowed at leaf base, gradually enlarged to laminal part, excurrent into hair-point, costa, seen in transverse section, on dorsal side rounded, at insertion and leaf base mammillose, on ventral side in basal part widely channelled, in laminal part channelled, at insertion and in leaf base 4 guide cells, occasionally the 2 outer ones contiguous with the basal cells, in laminal part 2 guide cells, a median group of hydroids, vanishing below apical part.

Sporophyte. *Seta* to 2.0-3.0 mm long, arcuate, vaginula 0.8 mm long, cylindrical, with ochrea. *Capsule* exserted, pendulous, ovoid, finely ribbed, exothecial cells elongated thin-walled, stomata large on base of capsule, neck none, annulus of two or three rows of cells, detaching easily as groups or singly. *Calyptra* cucullate. *Operculum* conical, mammillate, margin smooth, formed by a row of nearly isodiametric cells, in conical part cells irregular, walls thin. *Peristome* teeth erect, spreading when dry, broadly lanceolate, in upper half split into two or four divisions, occasionally imperfect or rudimentary, in places interconnected by anastomosis, separated down to the insertion, dorsal and ventral sides densely covered with fine papillae, trabeculae small, distant, in lower third sharply protruding. *Spores* 10-13 µm, smooth.

Diagnostic characters. – Gametophyte. Leaves broadest at mid-leaf, margins recurved on both sides at mid-leaf, unistratose except at apex on one side, rarely on both sides in one cell row, basal paracostal cells elongate-rectangular (Fig. 11E, F), walls nodulose. Sporophyte. Peristome teeth in upper half divided into two to four divisions, in places interconnected by anastomosis.

Distribution, habitat and ecology. – *Grimmia orbicularis* is a thermophilous species known from Mediterranean areas of Europe and North Africa extending northwards to the UK and the Netherlands, eastwards to Tibet and adjacent China, and also known from a scattering of localities in the southwest USA. In the southern hemisphere it is known only from South Africa, New Zealand and Uruguay.

In South Africa and Lesotho (Fig. 2C) *Grimmia orbicularis* is an uncommon species, mostly known from shales, or occasionally dolerite, in karoo (mostly succulent karoo) vegetation at low to medium elevation (300-1,000 m) in dry inter-montane valleys of the Western Cape, but with outlying populations in similar vegetation types in the Northern and Eastern Cape Provinces and the Free State.

Notes. – A total of 13 specimens were seen, one had sporophytes of which a few capsules were in a suitable state for examination. For differentiation between *G. orbicularis* and *G. pulvinata* see comments under the latter species.

Selected specimens examined. – **South Africa. Prov.Western Cape:** Cederberg, Algeria Forestry Station, N-facing side of valley behind campsite, 500-700 m. 32°19'42"S 19°05'37"E, 26.II.2000, *Hedderson 13047* (BOL); McGregor area, Riviersonderend Mountains, Boesman's Kloof, cliffs along path below De Galg, 34°00'40"S 19°42'30"E, c. 1000 m, 28.IX.2003, *Hedderson 15264* (BOL, G); Swellendam–Ashton area, W slopes of the Langeberg at the farm Sitruspoort, 33°56'50"S 20°16'20"E, c. 350 m, 11.X.2003, *Hedderson 15285* (BOL); 14 km S of Oudtshoorn, along road to George, small kloof above road, 500 m, 18.I.1979, *Magill 6097* (PRE).

10. ***Grimmia pulvinata*** (Hedw.) Sm. in Engl. Bot. 24: 1728. 1807 (Fig. 12).

≡ *Fissidens pulvinatus* Hedw., Sp. Musc. Frond. 158. 1801.

Lectotypus (designated by Cao & Vitt, 1986: 191): **Sine loc.:** "In tectis et muris vulgaris, vere maturans", s.d., *Anon. s.n.* (G [G00040350]!).

= *Fissidens pulvinatus* var. *africanus* Hedw., Sp. Musc. Frond. 159. 1801. **Lectotypus** (designated by Muñoz, 1999: 168): **South Africa:** "Ad Cap. bonae spei lecta, specimina misit O. Swartz", s.d., *Swartz s.n.* (G [G0004035]!), synonymized by Magill (1981: 275).

= *Grimmia ecklonii* Spreng., Syst. Veg. 4: 321. 1827. **Lectotypus** (designated by Muñoz & Pando, 2000: 67): **South Africa:** Swellendam, s.d., *Ecklon s.n.* (BM [BM000575940]!; isolecto-: BM [BM000670219] !), synonymized by Muñoz & Pando (2000: 67).

Gametophyte. *Monoicous. Female:* innermost perichaetial leaf 2.2-2.5 mm long, sheathing up to apical part, tubulose, hyaline in lower part of leaf, costa excurrent to long, bluntly denticulate hair-point; *male:* perigonium as bud of 4 or 5 leaves, on short stalk in leaf axil on stem of fruiting plant, close to perichaetium, innermost perigonial leaf 1 mm long, sheathing up to apex, concave, ovate, apex acute or mucronate, costa vanishing below apex, hyaline except at apex, paraphyses few. *Growth form*: cushion dense, lax, young shoots originating from detritus, leaflets with hair-point, plants radiculose at base, erect, dichotomously branched, stems up to 15 mm high, central strand developed. *Leaves* in lower part of stem small, with hair-point, becoming gradually longer, up to 2.5 mm long, crowded, loosely disposed on stem, upper part of leaf slightly flexuose when dry, especially the comal ones, apical part quickly bending backwards when moistened, erecto-patent when wet, broadest part of leaf in lower third, broad-lanceolate or lanceolate from a short, ovate leaf base, apex obtuse, hair-point denticulate; *leaf form*

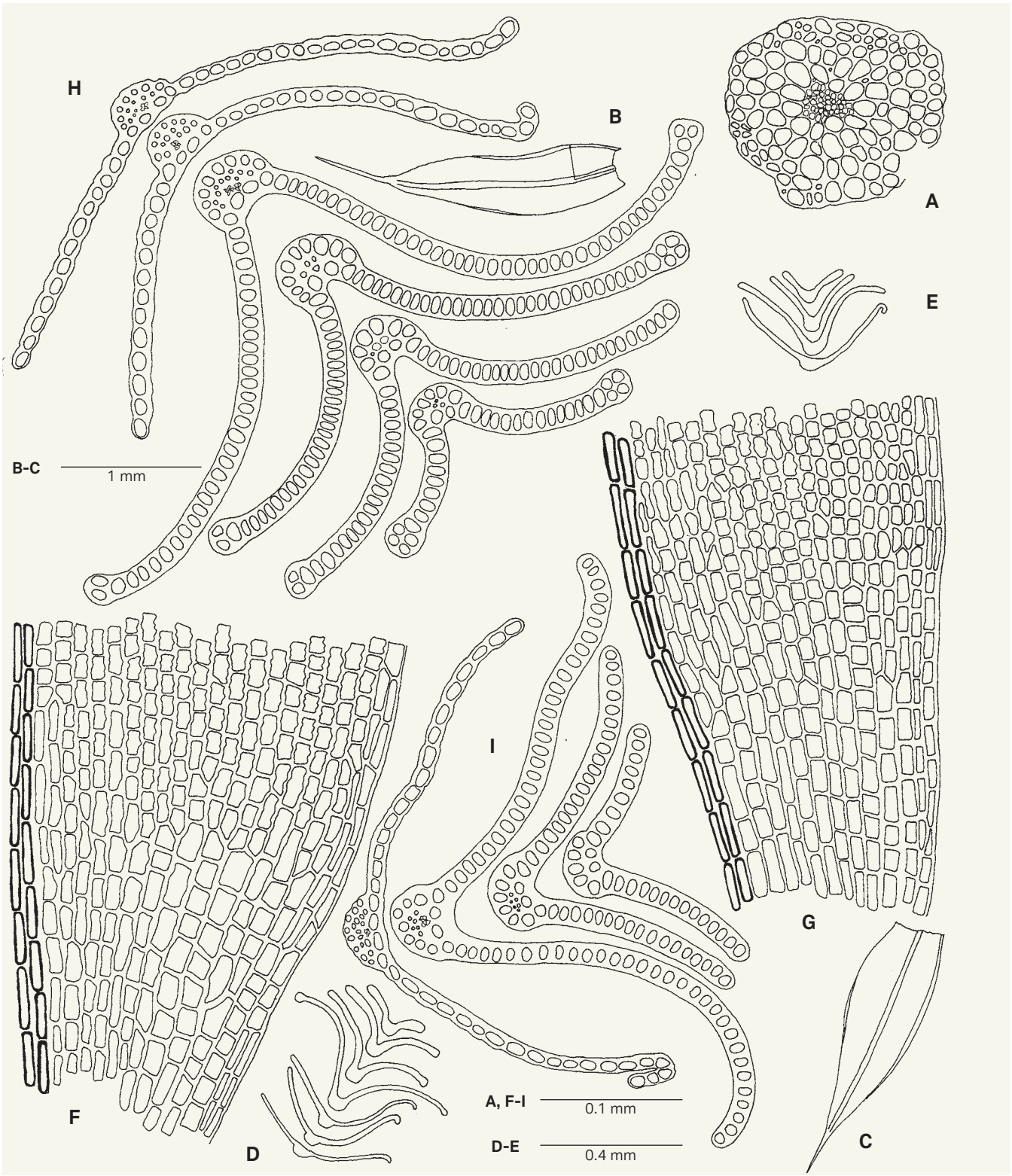

Fig. 12. – *Grimmia pulvinata* (Hedw.) Sm.: **A.** Transverse section of stem; **B**, **C.** Leaves; **D. E.** Outlines of transverse sections of leaves; **F**, **G.** Cells in leaf base; **H**, **I.** Transverse sections of leaves.
[**A, D, H:** *Hedderson 13601*, BOL; **C, F:** *Hedderson 13148*, BOL; **B**, **E**, **I:** *Hedderson 13851*, BOL; **G:** *Hedderson 13677*, BOL]

in situ, leaf base widely concave or concave, laminal part widely keeled, margin recurved on one side from insertion or leaf base up to above mid-leaf, rarely on the other side and then, at most, in the middle of the leaf; in leaf base some paracostal cell rows of slightly elongate-rectangular cells, walls smooth, towards margin cells short-rectangular, at margin one or two rows of rectangular cells which may appear hyaline, transverse walls thickened, all cell walls smooth, in transitional part cells rectangular, walls sinuose, in laminal part mostly isodiametric, walls somewhat sinuose, thickened, at apex cells isodiametric, lumina rounded; lamina, seen in transverse section, unistratose, margin at insertion and leaf base unistratose, in laminal part, at least in the very apical region, several marginal cell rows are bistratose on both sides or on one side only, even completely unistratose margins may be seen. *Costa*, seen on dorsal side, of nearly uniform width, faintly smaller in leaf base, percurrent, seen in transverse section, on dorsal side rounded, on ventral side at insertion and leaf base slightly concave, in laminal part above widest part of leaf widely channelled, at insertion and leaf base 4 guide cells, in laminal part reduced to two, at insertion and leaf base a small band of substereids or stereids and a median group of hydroids, gradually vanishing up to apical part.

Sporophyte. *Seta* up to 4.5 mm long, erect, twisted when old and dry, in immature and mature state arcuate or curved when wet, vaginula 0.8 mm long, cylindrical. *Capsule* erect when old, in immature and mature state pendent and hidden in cushion, obloid, in mature state with eight to ten ribs, exothecial cells elongated, walls curvilinear, thin, stomata numerous in short apophysis, annulus of three or four rows of cell, detaching in a spiral, cells of capsule at orifice with crenulate outer walls. *Calyptra* mitrate, lobed, covering upper part of capsule. *Operculum* with straight beak of variable length, margin crenulate, a marginal row of oval cells, cells in conical part mostly elongated of different shape. *Peristome*, teeth erect-spreading when dry, broad at base, elongate-lanceolate, in upper half split into two or three divisions, separated down to insertion, dorsal side smooth near insertion, the upper part of dorsal side and ventral side densely covered with fine papillae, trabeculae thin, neared, slightly protruding. *Spores* 8-11 µm, granulose.

Diagnostic characters. – Gametophyte. Leaves broadest in the lower third; margin recurved on one side from insertion or leaf base up to above mid-leaf, rarely so on the other side, and if so only in the middle of the leaf; leaf with one or two basal paracostal cell rows rectangular, towards margin cells short-rectangular, at margin one or two rows rectangular with thickened transverse walls which may appear hyaline, all cell walls smooth.

Distribution, habitat and ecology. – *Grimmia pulvinata* is a very widespread species that occurs on every continent except Antarctica. It is often common in temperate areas of the northern hemisphere, with some extensions northward into boreal zones, and (rarely) southward to subtropical areas. In the southern hemisphere this species is recorded from Australia, New Zealand, southern South America (Chile and Uruguay), and from southern Africa. Although frequently considered cosmopolitan, it is actually largely absent from the tropics and subtropics. In sub-Saharan Africa, for example, it appears to be largely restricted to the study area and adjacent Namibia, and is not recorded for any other country on the continent except Ethiopia. It is thus probably better considered a temperate species with some poleward extensions.

In South Africa and Lesotho (Fig. 2D), *G. pulvinata* is one of the two most common species of *Grimmia* encountered. It occurs over a broad altitudinal range (50 to 1,910 m), and in most of the major biomes, except for the various savannah and tropical thicket and forest types. Most collections are from quartzitic sandstones, but it also occurs on most other rock types (e.g. shales, granites, basalt) present in the region.

Notes. – A total of 167 specimens were seen of which 67 had sporophytes, although only 6 had capsules that were in a suitable state for examination whilst 9 were immature, and the remaining 52 were decomposed. The leaf shape in *Grimmia pulvinata* is variable. Leaves can vary from short ovate-lanceolate to elongated ovate-lanceolate, and small lanceolate forms also appear.

The hair-points can be longer than the lamina, whilst at the other extreme some plants have leaves with only a few hyaline cells at the apex or even lack the hair-point altogether. A specimen from the summit of the Zuurberge Range (*Alexander s.n.*, BOL) where all leaves are muticous was annotated by Dixon as "*G. pulvinata* var. *submutica*", a name that was never published.

The stratosity of the leaf margins is variable. In different leaves, even on the same plant, unistratose or bistratose margins may be observed. For the correct identification of *G. pulvinata*, and for its differentiation from *G. orbicularis*, the stratosity of the leaf margins is thus not very useful. A stable distinguishing character is provided by the paracostal cell rows in the leaf base. In *G. pulvinata* these (Fig. 12F, G) are slightly elongate-rectangular, becoming short-rectangular towards the margins and all cell walls are smooth. In *G. orbicularis* on the other hand (Fig. 11E, F), these are elongate-rectangular, with nodulose walls towards the costa, but rectangular to quadrate with smooth walls at the margins.

Other species have been subject to frequent misidentification as *G. pulvinata*, and amongst the material at BOL and PRE specimens of *G. consobrina*, *G. fuscolutea*, *G. laevigata*, and *G. pygmaea* were found to have been erroneously attributed to *G. pulvinata*.

Grimmia pulvinata grows from 250 to 2,000 m in Europe and North America (records from above 2,000 m should be checked), from 1,000 to 1,800 m in Asia, and from 50 to 1,910 m in South Africa. *Grimmia pulvinata* thus seems to be restricted to altitudes from sea level to 2,000 m across its range.

Selected specimens examined. – **South Africa. Prov. Western Cape**: Cape Peninsula, Silvermine NR, Silvermine Valley, just above "Sunbird Environmental Recreation Centre", 34°06'28"S 18°24'37"E, c. 50 m, 6.IV.2000, *Hedderson 13148* (BOL); Ceres District, Oliphants River Mountains. Beaverlac area, Ratel's River, c. 400 m, 32°54'27"S 19°04'01"E, 8.I.2001, *Hedderson 13601* (BOL); Citrusdal Region, Cederberg, Cederberg State Forest, Welbedacht Kloof, 900-1300 m, 32°24'30"S 19°10'24"E, 17.II.2001, *Hedderson 13677* (BOL); c. 4 km along R355 from intersection with R46 between Ceres and Touwsrivier Steep, c. 850 m, 33°11'10"S 19°47'05"E, 4.VI.2001, *Hedderson 13851* (BOL).

11. ***Grimmia pygmaea*** Müll. Hal., Syn. Musc. Frond. 1: 787. 1849 (Fig. 13).

– *Grimmia trichophylla* var. *australis* Hampe, in Syn. Musc. Frond. 1: 788. 1849. [nom. inval.].

Lectotypus (designated by Muñoz & Pando, 2000: 67): **Australia:** "Gr. trichoph.-australis Hamp. N. Holl.", s.d., *Anon. s.n.* (H-SOL!).

= *Grimmia drakensbergensis* Sim in Trans. Roy. Soc. South Africa 15: 209. 1926. **Typus: South Africa. Prov.Natal:** Top of Giants Castle. 2440 m, 1912, *Sim 9962* [leg. *Symons s.n.*] (holo-: PRE), synonymized by Maier (2010: 300).

Gametophyte. *Monoicous. Female:* innermost perichaetial leaf up to 2 mm long, sheathing, costa stout, percurrent, hair-point scarcely denticulate; *male:* perigonia in leaf axils or on short branches originating there, several on a stem, usually far from the perichaetium, innermost perigonial leaf 0.8 mm long, hyaline except the apical part, costa percurrent. *Growth form*: cushions adhering to the substrate by rhizoids or desintegrating, occasionally young shoots originating from the stem base, apices of the leaflets appressed to stem, plants erect, stems from 15 mm up to 70 mm high, branched by innovations, leaves arranged in tiers, stem with well-developed central strand. *Leaves* 1.5-2.5 mm long, densely set, in dry state appressed to stem, slightly turned, scarcely moving when moistened, erecto-patent when wet, from elongate-ovate leaf base lanceolate, tapering to acute apex, hair-point weakly denticulate; *leaf form in situ*, at base concave, lower laminal part keeled, upper part narrowly so, margins weakly recurved on both sides from above leaf base to upper part of lamina, apical part of lamina plane; basal cells elongate-rectangular, walls thickened, weakly to strongly nodulose, variable from leaf to leaf on the same plant, near margin two or three rows of shorter cells with smooth walls appearing hyaline and differentiated from the elongated nodulose basal cells, in transitional part lamina cells narrow, elongate-rectangular with mostly strongly sinuose walls becoming shorter towards the margin, in apical part cells isodiametric or short-rectangular, walls thickened, more or less sinuose; leaf base, seen in transverse section, unistratose, lamina mostly unistratose throughout, in rare cases with bistratose patches, margins unistratose in leaf base and lower half of lamina, in upper part of lamina one to three marginal rows bi- or even tristratose. *Costa*, seen on dorsal side, of nearly uniform width, slightly thinner in leaf base, percurrent, costa, seen in transverse section, dorsally rounded, from above insertion to below apical part the costa being prominent, in laminal part exterior walls of dorsal cells markedly thickened, on ventral side in basal part widely channelled, in laminal part channelled, at insertion and at leaf base with 4 guide cells, in laminal part 2 guide cells, in mid-leaf small and elliptic in shape, mostly obliquely arranged to leaf axis, in leaf base and laminal part a centrally arranged group of hydroids or only one big star-shaped hydroid, vanishing in apical part, the dorsal costal cells with a small rounded lumen, transformed to substereids or stereids in the lower part of the leaf, in the prominent part of the costa a series of stereids arranged around the hydroids.

Sporophyte. *Seta* to 2 mm long, arcuate or curved, vaginula 0.8 mm long, cylindrical. *Capsule* exserted, horizontal or slightly pendulose, obloid, ribbed, exothecial cells elongated, rectangular, penta- and hexagonal, walls thin, stomata numerous on short neck, annulus of 3 to 4 rows of cells detaching in fragments, cells at orifice of capsule with smooth, or rarely slightly crenulate outer walls. *Calyptra* mitrate, covering the upper third of capsule. *Operculum* conical with short beak, at rim some rows of cells with rounded lumina, in conical part rectangular or of irregular shape. *Peristome* teeth erect when dry, lanceolate, divided in the upper half into two divisions, the lower dorsal plates smooth, the subsequent plates with fine papillae, upper dorsal and ventral sides densely covered with rough papillae, trabeculae small to broad throughout, distant. *Spores* 11-15 µm, nearly smooth.

Diagnostic characters. – Gametophyte. Cells in leaf base elongate-rectangular with nodulose walls, lamina cells in transitional part elongate-rectangular with sinuose walls. Costa rounded except from above insertion up to below apical part where the costa is prominent and the exterior walls of dorsal cells are markedly thickened. In the same part, the guide cells are small and elliptic, mostly arranged obliquely to the leaf axis, whilst in the leaf base and laminal part a centrally arranged group of hydroids or one star-shaped hydroid can be observed, vanishing in the apical part.

Distribution, habitat and ecology. – *Grimmia pygmaea* is a south-temperate species, known from New Zealand, Australia, Patagonia, and the Kerguelen Islands.

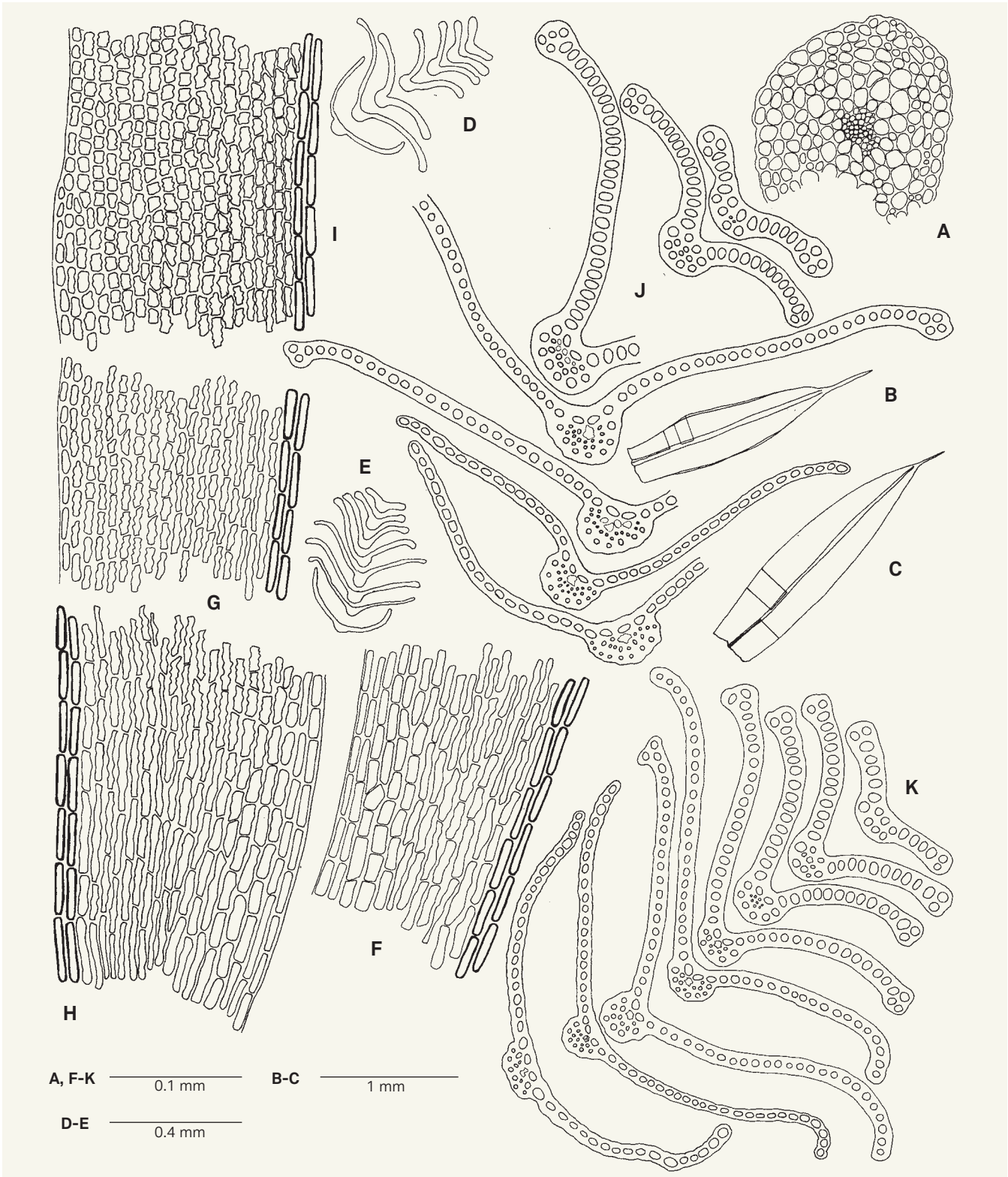

Fig. 13. – *Grimmia pygmaea* Müll. Hal.: **A.** Transverse section of stem; **B**, **C.** Leaves; **D**, **E.** Outlines of transverse sections of leaves; **F.** Cells in leaf base; **G.** Cells in transitional part; **H.** Cells in leaf base; **I.** Cells in transitional part; **J**, **K.** Transverse sections of leaves.
[**A:** *Duckett & Matcham 1246a*, Herb. Matcham; **B**, **D**, **F**, **G**, **J:** *Esterhuysen 35934*, BOL; **C**, **E**, **H**, **I:** *Hilliard & Burtt*, BM; **K:** *Magill 4204*, BOL].

In South Africa and Lesotho (Fig. 2E) *G. pygmaea* is the most common species of *Grimmia* at high altitudes (>2,500 m) in the Drakensberg of Lesotho and adjacent South Africa, where it grows on basalt. Within the study area the vast majority of known populations are from this region. However, it is also known from a smattering of localities in the southern part of the Cape Fold Mountains, and from two intermediate stations along the Great Escarpment. In the western part of its range it mostly occurs on quartzitic sandstone at high altitude, but occasionally descends to near sea level (e.g. on the Cape Peninsula).

Notes. – A total of 79 specimens were seen for this study and 38 of these had sporophytes, of which 3 were in a suitable state for examination, 9 were immature and 27 were decomposed. This species has been misunderstood, and largely neglected. Specimens from the study area were almost invariably identified as *G. pulvinata*. Whilst the two species are superficially similar, the paracostal cell differences (elongate-rectangular and nodulose in *G. pygmaea* versus shorter and smooth-walled in *G. pulvinata*) are diagnostic. Furthermore, *G. pulvinata* is predominantly found at lower elevations (not known from > c. 1,900 m), whilst most collections of *G. pygmaea* are from higher altitudes, although in the Western Cape it can occur at much lower elevations. The costal anatomy will also readily distinguish *G. pygmaea* from both *G. orbicularis* (also superficially similar, but ecologically very different) and *G. pulvinata*.

Selected specimens examined. – **Lesotho:** Mokhoapong Pass, along Mountain Road, 147 km E of Maseru, 2710 m, 30.XI.1977, *Magill 4204* (BOL); Moseru District. Thaba-Putsoa (High Pass) on the road to Semonkong. 3090 m, 29°44'S 27°57'E, 20.IV.1994, *Duckett & Matcham 1246a* (herb. Matcham). **South Africa. Prov. Natal:** Drakensberg area, Umgatsheni valley between Sani Pass and Vergelegen, c. 2130 m, VII.1983, *Esterhuysen 35934* (BOL); E. Cape, Lady Gray Distr., Witteberg, Joubert's Pass, 2440 m, 18.I.1979, *Hilliard & Burtt 12221* (BM).

12. ***Grimmia sessitana*** De Not. in Atti Reale Univ. Genova 1: 704. 1869 (Fig. 14).

Lectotypus (designated by Cao & Vitt, 1986: 164): **Italy:** "Frane alle scaturigini del Vogna, sotto l'ospicio della Valdobbia, in Val Sesia", s.d., *Carestia 55* (RO; isolecto-: G [G00052457]!).

Gametophyte. *Monoicous,* occasionally *dioicous. Female:* innermost perichaetial leaf sheathing, 2.6-2.8 mm long, concave; *male:* perigonia as buds on short stalks on branches of female plants, terminal or in leaf axils, several on one plant. *Growth form*: cushions dense, compact, adherent to substrate with rhizoids, stems to 20 mm high, plants erect, radiculose at base, strongly branched, central strand developed. *Leaves* crowded, in lower part of stem to 1.2 mm long, muticous or short hair-point present, becoming gradually longer, to 2.4 mm long, loosely arranged on stem, apices flexuose when dry, rapidly bending backwards when moistened, quickly moving to erect or erecto-patent position when wet, from nearly rectangular or ovate leaf base lanceolate, tapering to acute apex, hair-point nearly smooth; *leaf form in situ*, at insertion and in leaf base concave, narrowly keeled in laminal part, margin recurved on one side from insertion to broadest part of leaf or plane on both sides; basal paracostal cells in upper stem leaves, elongate-rectangular, walls thin, smooth, cells at margin elongate-rectangular, nearly of the same length as paracostal cells, transverse walls thickened, in lower stem leaves paracostal cells elongate-rectangular, towards margin some rows short-rectangular or quadrate, transverse walls thickened, smooth, all leaves with some hyaline marginal cell rows, vanishing at broadest part of leaf, above broadest part of leaf cells short rectangular to quadrate, lumina rounded, walls smooth or slightly sinuose, in apical part isodiametric, lumina rounded, walls thickened; leaf, seen in transverse section, at base unistratose, laminal part unistratose, bistratose in places or nearly completely bistratose, in surface view seen as striae. *Costa*, seen on dorsal side, enlarged from above broadest part of leaf to apex, excurrent, seen in transverse section, dorsally rounded, ventrally at insertion and in leaf base channelled, in laminal part narrowly or very narrowly so, at insertion and in leaf base 4 guide cells, in laminal part 2 guide cells, a median group of hydroids present, in upper part of leaf transformed to substereids.

Sporophyte. *Seta* to 4 mm long, rarely straight mostly slightly inclined, vaginula 0.6 mm long, short cylindrical, with ochrea. *Capsule* exserted, erect, oblong-ovoid, constricted at capsule mouth after spore release, smooth, exothecial cells mostly hexagonal, elongate, walls thin, seen in transverse section of capsule, exterior walls slightly bulging, stomata at base of capsule, numerous or few, neck lacking, annulus of 3-4 rows of persistent cells, which may detach singly, seen in surface view quadrate to transversely rectangular, lumina large. *Calyptra* cucullate. *Operculum* conical, blunt, base uneven, formed by two rows of small, nearly isodiametric cells, in conical part cells irregular, rectangular, isodiametric, lumina rounded. *Peristome* teeth erect or spreading when dry, lanceolate, entire or perforate, separated down to insertion, lower dorsal side smooth, upper dorsal and ventral sides covered with rough papillae, trabeculae in lower part small, in upper part thin. *Spores* 8-9 µm, smooth.

Diagnostic characters. – Gametophyte. Upper stem leaves with marginal cells elongate and nearly the same length as paracostal cells, whilst in the base of lower stem leaves the marginal cells are short-rectangular to quadrate. In all leaves cells are smooth with thickened transverse walls, some cell rows are hyaline, vanishing above leaf base. Costa, enlarged from above broadest part of leaf to apex.

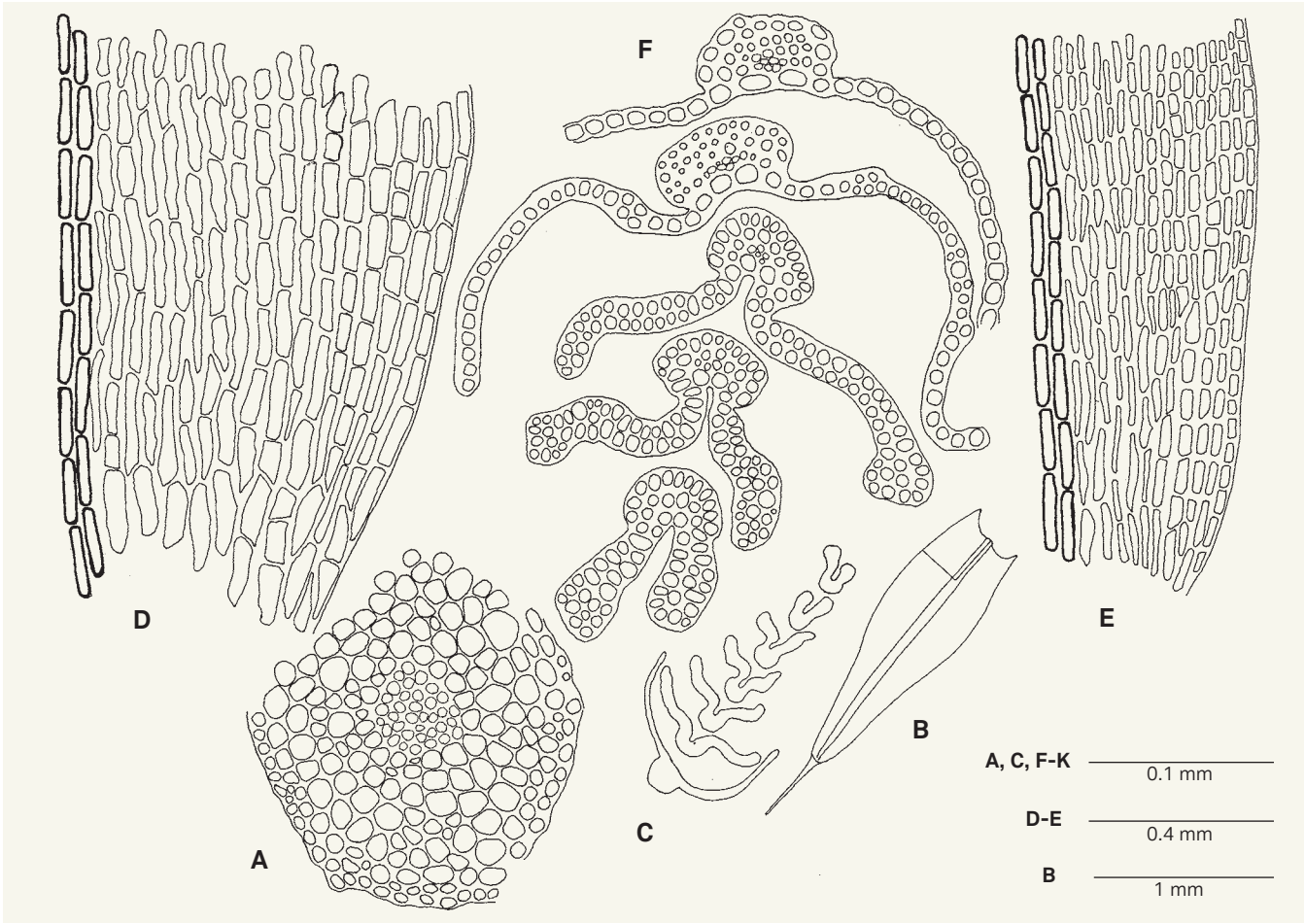

Fig. 14. – *Grimmia sessitana* De Not.; **A.** Transverse section of stem; **B.** Leaf; **C.** Outlines of transverse section of leaf; **D.** Cells in leaf base of upper stem leaf; **E.** Cells in leaf base of lower stem leaf; **F.** Transverse section of leaf.
[**A, C, F:** *Esterhuysen 20971*, BOL; **B**, **D**, **E:** *Schelpe 8037*, BOL]

Distribution, habitat and ecology. – In the northern hemisphere *Grimmia sessitana* is widely, but disjunctively, distributed in mountainous regions. It is known from eastern and western North America, Europe, and the high mountains of Asia, including from Japan. In the southern hemisphere it is known only from the study area, New Zealand, the Falkland Islands, the South Shetland Islands and the Queen Mary Coast of Antarctica.

Grimmia sessitana is rare in the study area (Fig. 2F). It is known from four high altitude (1,670-1,940 m) sites in the mountains of the Western and Northern Cape Provinces, three in the Hex River Mountains and one on the Hantamsberg. In all four localities it grows on more or less sheltered ledges of quartzitic sandstone.

Notes. – Four specimens were seen and all were sterile. *Grimmia reflexidens* Müll. Hal., a name occasionally used on labels of South African specimens, is not a synonym of *G. sessitana*. The arguments for the correct use of the name *G. sessitana* De Not. are given in Maier (2002 : 224; 2010 : 357).

Selected specimens examined. – **South Africa. Prov. Cape :** Ceres Dist., Roodeberg, Hex River Mts. Shelf at foot of cliffs, S side, 2130 m, 27.XII.1952, *Esterhuysen 20971* (BOL); Hantamsberg plateau, near F.M. tower, 3119 BD, 25.IX.1980, *Schelpe 8037* (BOL).

13. ***Grimmia tortuosa*** Hook. f. & Wilson in London J. Bot. 3: 540. 1844 (Fig. 15).

Lectoypus (designated by Muñoz, 1999: 174): **United Kingdom. Falkland Islands Dependencies:** "Antarct. Exp. 1938-1843", s.d., *Hooker s.n.* (BM [BM001007061]!; isolecto-: NY [NY01162773]!).

Gametophyte. *Monoicous* (fide Cao & Churchill, 1995 and Muñoz, 1999). Neither sporophytes nor perigonia seen. *Growth form:* cushions dense, compact, adherent to substrate by smooth rhizoids, plants sap green, radiculose at base, ascending, branched, stems up to 10 mm high, central strand well-developed or not at all, with intermediate states on one and the same stem. *Leaves* on lower part of stem muticous, 0.3-1.0 mm long, suddenly becomimg markedly longer, up to 2-3 mm long, crowded, contorted, forming comal tuft when dry, scarcely moving when moistened, erecto-patent, stiff when wet, from elongate leaf base lanceolate, tapering to acute or obtuse apex, hair-point of different lengths, bluntly denticulate; *leaf form in situ*, at insertion and in leaf base concave, in transitional part widely keeled, in lower laminal part keeled, in upper laminal part narrowly or very narrowly so, margins plane throughout; basal cells hyaline, elongate-rectangular, longitudinal and transverse walls of even thickness, thin and smooth, scarcely nodulose, towards margin the hyaline cell rows gradually vanishing, outermost row reaching up to the broadest part of leaf, thus forming between hyaline basal cells and thicker walled chlorophyllose lamina cells a more or less well expressed delimitation, running obliquely from costa to margin, lamina cells isodiametric, lumina rounded; lamina, seen in transverse section, unistratose throughout, margin unistratose at leaf base, in upper half of leaf some cell rows bistratose or tristratose. *Costa*, seen on dorsal side, small at leaf base, markedly stout in laminal part, indistinct at apex, percurrent or excurrent to hair-point, seen in transverse section, at insertion and leaf base rounded, from there up to apex prominent, on ventral side at insertion plane, in transitional zone widely channelled, in upper half of leaf narrowly channelled, from insertion up to below apical part 4 guide cells, in apical part 2 guide cells, at insertion and leaf base costa composed of nearly uniform substereids, transformed in laminal part to a large band of stereids, dorsal cells with large lumina, no hydroids seen throughout. Sporophyte. Not seen.

Diagnostic characters. – Gametophyte. Leaves with margins plane on both sides throughout. Costa in laminal part prominent, with a large band of stereids, and hydroids lacking.

Distribution, habitat and ecology. – *Grimmia tortuosa* is currently known only from the type locality in the Falkland Islands, and the locality newly reported here from the study area.

In South Africa and Lesotho (Fig. 2F), *Grimmia tortuosa* is currently known from a single locality at 1,940 m on the Waiihoekberge, at the southern end of the Hex River Mountains, where it occurs on damp, hard, quartzitic sandstone slabs in a shallow ravine where snow occasionally lies in late winter. Other species associated with it (e.g. *Blindia magellanica* Müll. Hal., *Platyneurum praealtum* (Mitt.) Ochyra & Bednarek-Ochyra) also exhibit similar disjunctive distributions.

Notes. – The description here is based on a unique, sterile specimen (*Hedderson 14459,* BOL). The descriptions given by Cao & Churchill (1995) and Muñoz (1999) as well as the protologue in Hooker & Wilson (1844) have also been taken into consideration for the description. Although geographically incongruous, the plants from South Africa match with both the description and the types of *G. tortuosa*, including the distinctive characters of a costa that is exceptionally rich in stereids below the middle of the leaf (see Fig. 15E).

Specimen examined. – **South Africa. Prov. Western Cape:** Ceres area, Waaihoek Berge, Waaihoek Peak, c. 1940 m, 33°28'15"S 19°18'54"E, 18.III.2002, *Hedderson 14459* (BOL).

Species excluded from South Africa and Lesotho

Grimmia ovalis (Hedw.) Lindb.

All specimens we have seen labelled as this species have proven to belong to other taxa. For example, of the ten BOL collections under this name, three (*Esterhuysen 18696, 19872, 24422*) are *G. montana*, whilst seven (*Esterhuysen 21637, 35931, Magill 4122, Schelpe 2106, 2116*) are *G. longirostris*. Magill (1981: 14-19, Fig. 82) cites *Schelpe 2116* as *G. ovalis* and his illustration of this species is based partly on *Killick 4207*. However, the transverse leaf sections (Fig. 82.18) are those of *G. longirostris* rather than *G. ovalis,* as seen in Maier (2010: 263, 265). Thus we have been unable to confirm the presence of *G. ovalis* in the study area and, despite Magill's (1981: 277) note that it is "a very widespread species", we here exclude it from the local flora.

On a global scale, *G. ovalis* and *G. longirostris* have long been confused, and it is only relatively recently that the distinctions between them have been clarified. It is thus not surprising that *G. ovalis* had mistakenly been attributed to the study area (e.g. Magill & Schelpe, 1979; Schelpe, 1979; Sim 1926: 210).

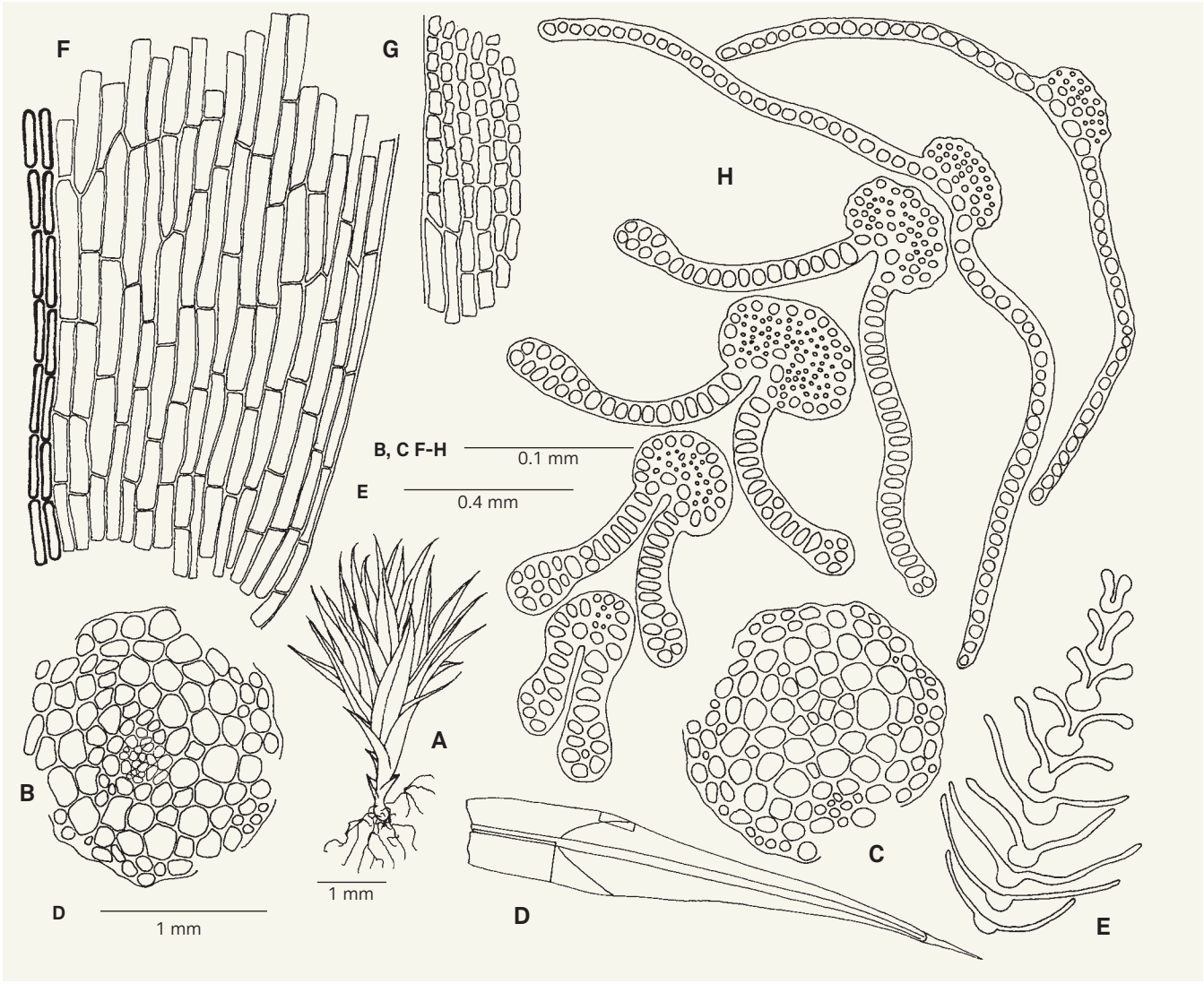

Fig. 15. – *Grimmia tortuosa* Hook. f. & Wilson: **A.** Plant; **B.** Transverse section of stem, with central strand; **C.** Transverse section of stem, without central strand; **D.** Leaf; **E.** Outlines of transverse section of leaf; **F.** Cells in leaf base; **G.** Cells at leaf margin in the broadest part of leaf; **H.** Transverse section of leaf.
[**A-H:** *Hedderson 14459*, BOL]

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Appendix 1. Glossary. Commonly used terms are taken from Smith (1978) and from Magill (1990), cited here with their English cross-reference numbers.

Air space: a hollow space between the capsule wall tissue and the outer spore sac in the mature capsule (Maier, 2004: 54, Fig. 1).

Costa channelled: shape as seen on the ventral side, described as 'hollowed out like a gutter and semi-circular in cross-section' (Magill, n° 201), determined here as widely channelled or channelled, as seen in *G. kidderi* (Fig. 7I) or in *G. laevigata* (Fig. 8H).

Costa prominent: shape as seen on the dorsal side, seen in transverse section; prominence is produced by contraction of costa at the origin of lamina, as seen in *G. tortuosa* (Fig. 15H).

Costa rounded: shape on dorsal side, seen in transverse section, expressed in breadth : thickness ratio, determined as widely rounded, as seen in the lower leaf of *G. longirostris* (Fig. 9F) or rounded, as seen in *G. consobrina* (Fig. 3F, G).

Guide cells: large, vacuolated cells in the leaf costa (Magill, n° 483). In *Grimmia* species they are ventrally arranged and their number is of taxonomic value.

Hydroids: thin-walled cells arranged dorsally between guide cells ('Begleiterzellen', Lorentz, 1868) and stereids or substereids. In younger leaves the cell walls are thin, whereas in mature leaves hydroid cells are star-shaped with concave walls and they appear in groups in stereid bands.

Insertion: the lowest row of cells at the leaf base, the inferior delimitation of a leaf, counterpart of 'the place or line of attachment of a structure' (Magill, n° 572).

Joint thickenings: thickenings (Deguchi, 1979), seen in transverse section, developed on both ends of vertical cell walls where two cells come into contact, to be seen occasionally in *G. consobrina* or *G. fuscolutea* (Fig. 6F).

Lamina: part of leaf extending from above leaf base to the apex, divided into lower lamina, upper lamina, and a short part in the leaf point designated as the apical part.

Leaf base: lowest part of leaf extending from insertion up to transitional part, generally the broadest part of leaf, mostly 1/3 to 1/4 of leaf length, c. 1/5 in *G. laevigata*. Cell shape, especially that of the elongated para-costal cells, is different from the cell shape above the transitional part.

Leaf concave: description of the natural spatial aspect, originated by disposition of the lamina relative to leaf axis, seen in outlines of a series of transverse sections shown at low magnification, determined as widely concave or concave, as in *G. laevigata* (Fig. 8G, H) or in lower half of the leaf of *G. kidderi* (Fig. 7I).

Leaf keeled: description of the natural spatial aspect, originated from the disposition of the lamina relative to leaf axis, seen in outlines of a series of transverse sections shown at low magnification, opening expressed in degrees of circle, determined as widely keeled >45°, keeled c. 45°, narrowly keeled <45°, spreading c. 90°.

Leaf form in situ: the natural spatial aspect of a leaf in wet state as it appears inserted on the stem, to be seen in a series of outlines of transverse sections at low magnification.

Spore sac: a cell layer of the amphithecium (Maier, 2004: 54, Fig.1).

Trabeculae: cross-bars formed from residual horizontal cell walls on the dorsal side of peristome teeth, determined as broad, as in *G. consobrina,* or small, as in *G. longirostris* in lower part of tooth and thin in upper part.

Transitional part of leaf: zone between leaf base and lamina, generally located in the broadest part of leaf, where elongated cells of leaf base with smooth or nodulose walls change to shorter cells of the laminal part with mostly sinuose walls. At the same place the elongated costa cells change to short cells.

Ventral cells: cells of an undefined number on the adaxial surface of leaves with broad costae. Most of them are guide cells, joined to them at both sides of the costa are cells with narrow lumens, probably paracostal cells, such as in *G. laevigata* (Fig. 6H).